Name Date 231

Comparing Mitosis And Meiosis

17

Your body carries out two different kinds of nuclear division. One is called mitosis and results in formation of new body cells for growth and repair. A second process is called meiosis and results in formation of reproductive cells only. There are several important differences between mitosis and meiosis.

In this investigation, you will
(a) compare the process of mitosis with meiosis.
(b) use model diagrams to show changes in cells during mitosis and meiosis.

Materials

pages of cell outlines
4 wool strands (15 mm long)
4 wool strands (30 mm long)

Procedure

Part A. Mitosis

Your teacher will supply you with outline diagrams for Part A of this experiment. Use only diagrams A, B, and C for Part A.

- Place the diagrams one below the other in proper order on your desk.

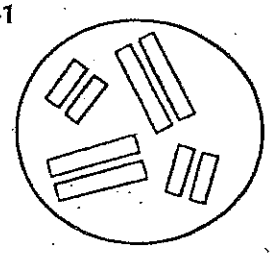
- Diagram A represents the outline of a cell before cell division or mitosis begins. Chromosomes are present inside the nucleus (but usually cannot be seen). Use wool strands to represent chromosomes. NOTE: A cell may contain many chromosomes. You will use only 4 chromosomes to help simplify this study.

- Place two long and two short pieces of wool (chromosomes) onto diagram A.

1. What is the total number of chromosomes present in this cell before mitosis? _____
2. How many long chromosomes are present before mitosis? _____
3. How many short chromosomes are present before mitosis? _____

- Before the cell begins mitosis, each chromosome makes an exact copy of itself. This process is called chromosome replication

FIGURE 17-1



chromosome replication

- To show chromosome replication, match new strands of wool with each original. Long should match with long, short with short (Figure 17-1).

- Transfer your chromosomes to diagram B, and position them within the dashed outlines. During mitosis, doubled chromosomes line up along the cell's center.

4. What differences (if any) are there between the original and replicated (copy) part of each chromosome? _____

Doubled chromosomes now separate, and each part is pulled toward one end of the cell.

- Move those chromosomes lined up along the left side toward the cell's left. Move those chromosomes lined up along the right side toward the cell's right. Use the arrows as guides.

• Once the doubled chromosomes separate, the original cell begins to pinch in half down the center. This process forms two new cells.

• Move the chromosomes on the left side of diagram B to the left cell of diagram C.

• Move the chromosomes on the right side of diagram B to the right cell of diagram C.

5. What is the total number of chromosomes present in each cell after mitosis (diagram C)?

_____

6. How many long chromosomes are present in each new cell? _____
7. How many short chromosomes are present in each new cell? _____
8. Compare your answers in questions 1-3 to those in questions 5-7. Are the two new cells just formed the same in chromosome makeup as the original cell? _____

In summary, some important things about mitosis include:

(a) every new nucleus formed has the same chromosome number as the original nucleus,
(b) paired chromosomes are present,
(c) mitosis occurs in all body cells (somatic cells), and
(d) mitosis is responsible for growth and cell repair.

Part B. Meiosis

• Your teacher will supply you with outline diagrams for Part B of this experiment. Use only diagrams D, E, F, and G for Part B. Place the diagrams one below the other in proper order on your desk.

• Diagram D represents the outline of a cell before meiosis begins. Chromosomes are present inside the cell. Place two long and two short pieces of wool (chromosomes) onto cell diagram D.

9. What is the total number of chromosomes present in this cell before meiosis? _____
10. How many long chromosomes are present before meiosis? _____
11. How many short chromosomes are present before meiosis? _____
12. Check back to questions 1-3. Are there differences so far between mitosis and meiosis?

_____

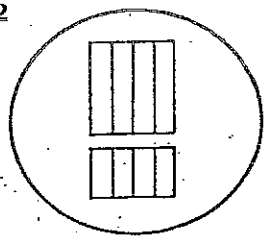
Before meiosis begins, the chromosomes replicate.

• Match new strands of wool with each original. Long should match with long, short with short. Before transferring your chromosomes to diagram E, one important step that is different in meiosis now occurs. One doubled long chromosome now pairs with the other doubled long chromosome.

• Place the four long chromosomes together.

• Do the same for the four short chromosomes which also pair at this stage. Each group of four is now called a tetrad (tetra = 4) (Figure 17-2).

FIGURE 17-2



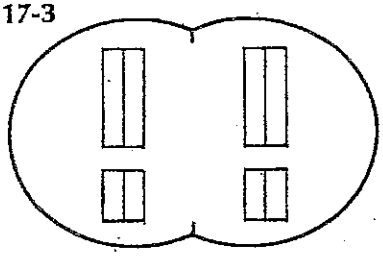
chromosome tetrads

13. Did this step occur in mitosis? _____

• Place your chromosome tetrads onto diagram E. Use the chromosome outlines to properly position them. During meiosis, the chromosome tetrads line up along the cell's center.

Chromosomes now separate and are pulled toward opposite ends of the cell. They separate, however, in a certain way. Each tetrad separates into the two original doubled chromosomes (Figure 17-3).

FIGURE 17-3



separating tetrads

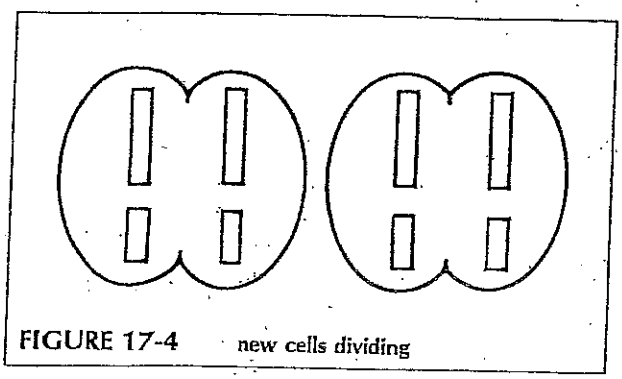


FIGURE 17-4 new cells dividing

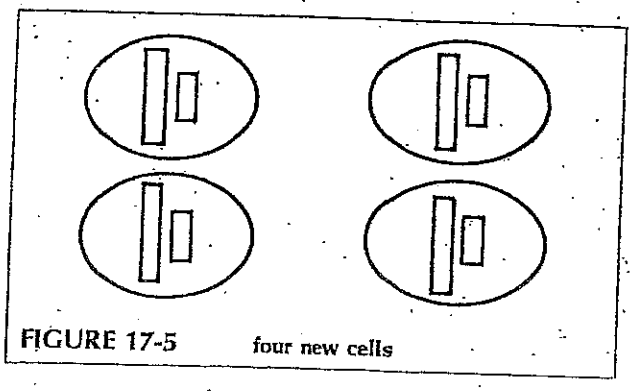


FIGURE 17-5 four new cells

● Move the doubled chromosomes toward opposite cell ends. Move those pairs lined up along the left center toward the left side of the newly forming cell. Follow the arrows as guides.

● Move the pairs lined up along the right center toward the right side of the newly forming cell. Follow the arrows as guides. Two new cells are formed as the original cell (Figure 17-3) pinches into two.

● Transfer those chromosomes on the right side of diagram E to the right circle of diagram F and position them within the dashed lines. Move those on the left side of diagram E to the left circle of diagram F and position them within the dashed lines.

14. (a) How many chromosomes are now present in each cell? _____
    (b) How many chromosomes were present in the original cell? _____
    (c) Is this step different from that which occurs after two cells form in mitosis? _____

Each new cell just formed, quickly begins to divide again into two new cells (Figure 17-4). This step results in four new cells being formed from the original cell (Figure 17-5). The doubled chromosomes then separate leaving each new cell with a reduced number of chromosomes.

● Move your chromosomes from diagram F to diagram G. Position the chromosomes within the dashed lines.

15. (a) How many new cells are formed from one cell by meiosis (diagram G)? _____
    (b) Does this step differ from mitosis? _____ Explain. _____

16. (a) What is the total number of chromosomes present in each new cell after meiosis? _____
    (b) Do any of the four new cells contain two long or two short chromosomes? _____

In summary, some important things about meiosis include:

(a) every new cell formed by meiosis has half the number of chromosomes as the original cell,
(b) no paired chromosomes are present,
(c) meiosis occurs only in reproductive organs, and
(d) meiosis is responsible for forming egg and sperm (gamete) cells.

Analysis

1. How many pairs of chromosomes are in each human body (somatic) cell? _____
2. How many pairs of chromosomes are in each egg or sperm? (Be careful.) _____

3. In the exercise on meiosis just completed,

(a) are the chromosomes in pairs in the new cells? _____

(b) how does this differ from the process of mitosis? _____

_____

4. In humans, 46 chromosomes are in each body (somatic) cell, and 23 chromosomes are in each reproductive cell. In the chart below, fill in the chromosome number and process for each cell type.

CELL TYPE	NUMBER OF CHROMOSOMES IN CELL	PROCESS USED TO MAKE CELL (MITOSIS OR MEIOSIS)
stomach		
liver		
sperm		
heart		
egg		

5. Complete the following chart by checking the process of cell division in which each step occurs.

	MITOSIS	MEIOSIS
Two new cells are formed from each original		
Four new cells are formed from each original		
Replication of chromosomes occurs		
Doubled chromosomes pair to form tetrads		
Cells with a reduced chromosome number are formed		
Cells with the same chromosome numbers as original are formed		
Results in forming egg or sperm cells		
Results in forming somatic or body cells		
Each original cell divides only once		
Each original cell divides twice		
Tetrads are not formed		
Chromosomes move to the cell's center		

DIAGRAMS FOR INVESTIGATION 17, "COMPARING MITOSIS AND MEIOSIS"

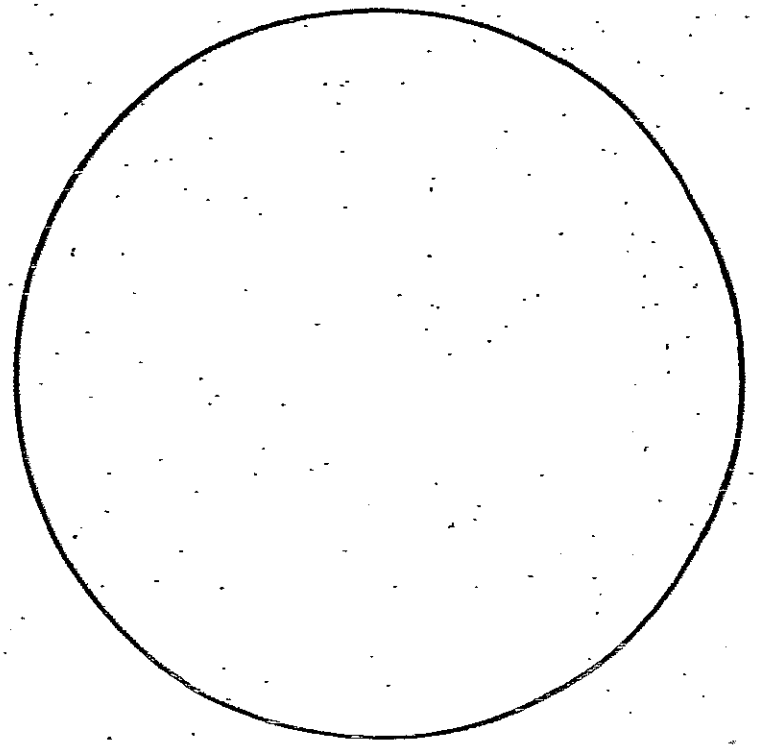


DIAGRAM A

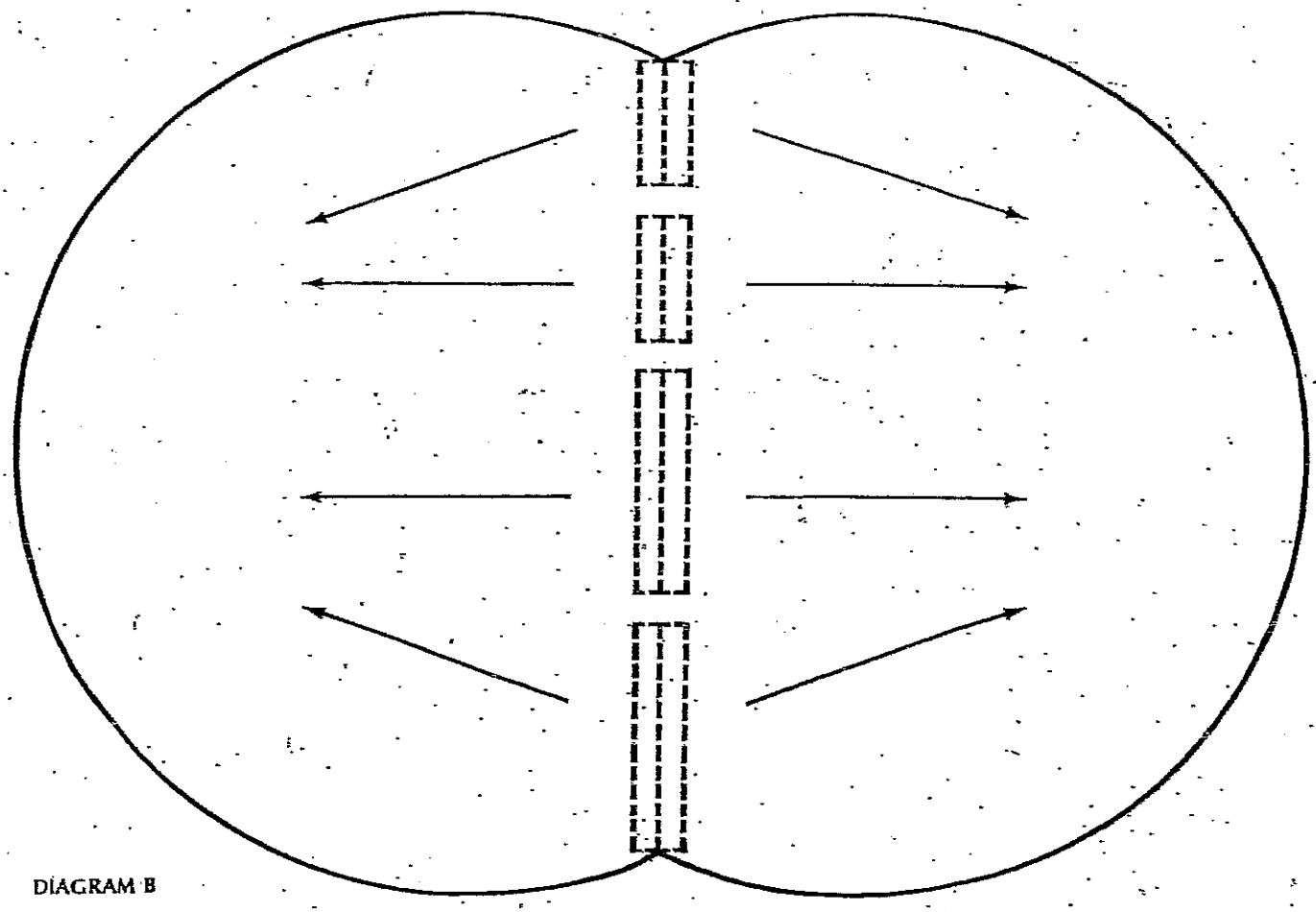


DIAGRAM B

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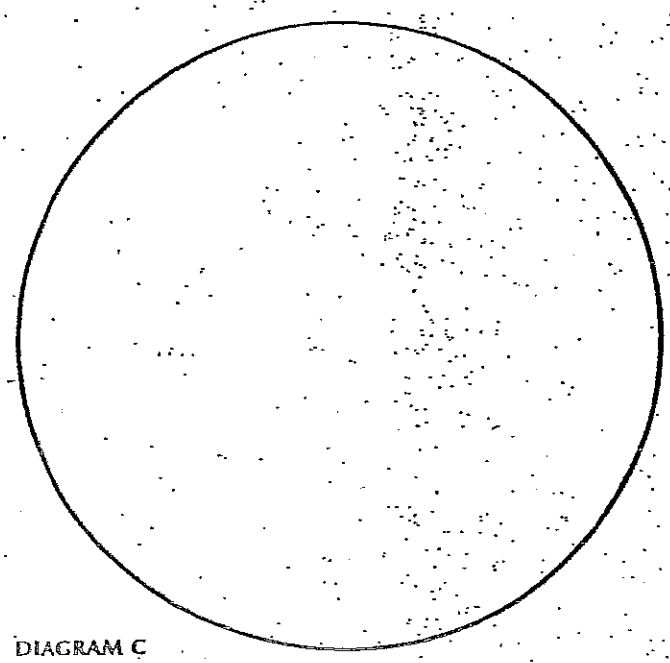
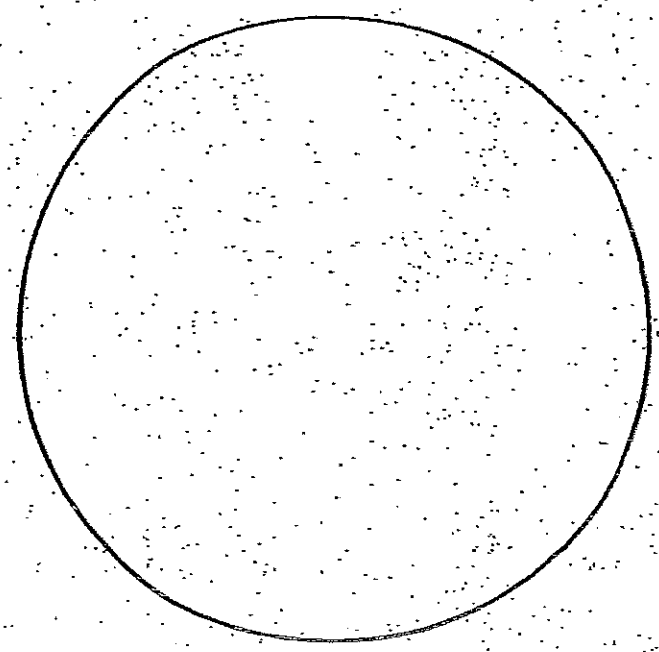


DIAGRAM C

new cell



new cell

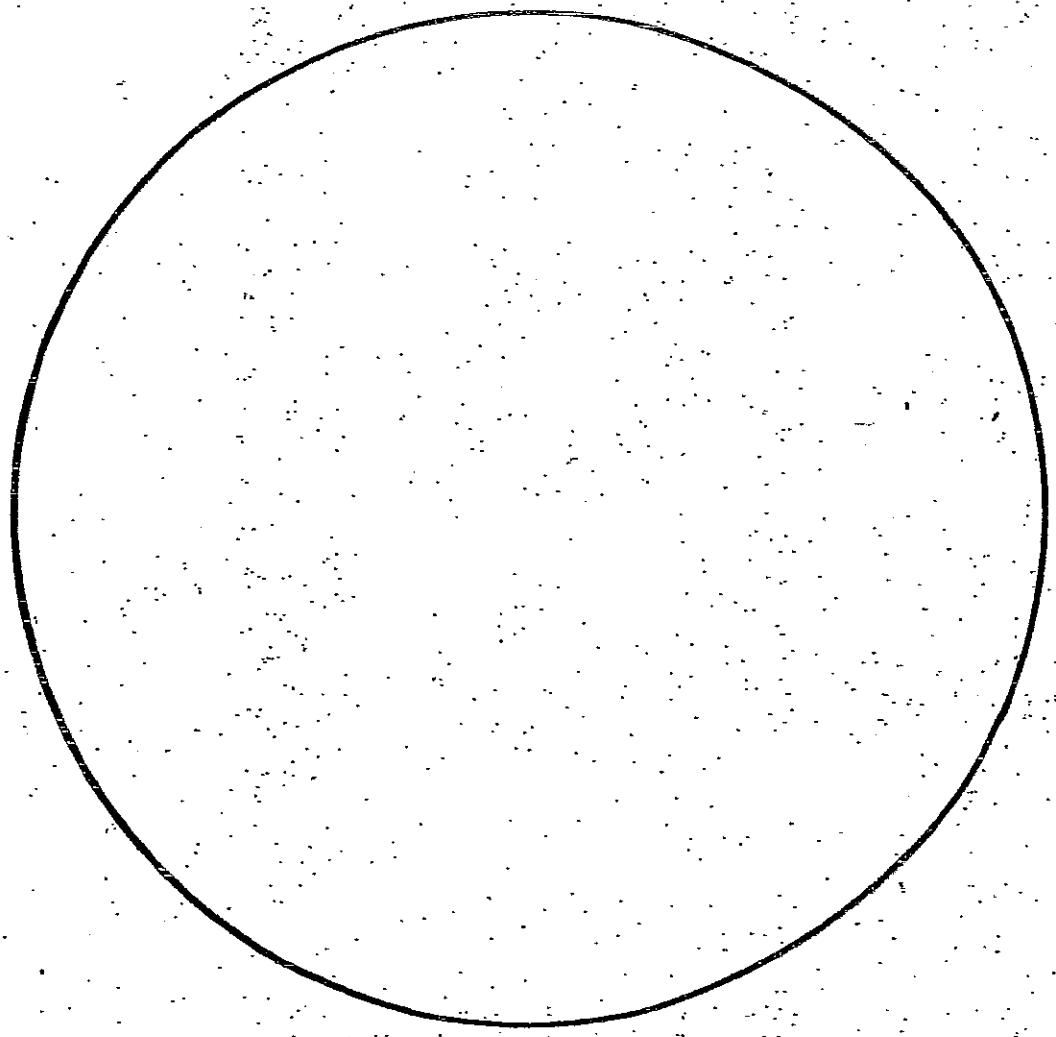


DIAGRAM D

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DIAGRAMS FOR INVESTIGATION 17, "COMPARING MITOSIS AND MEIOSIS"

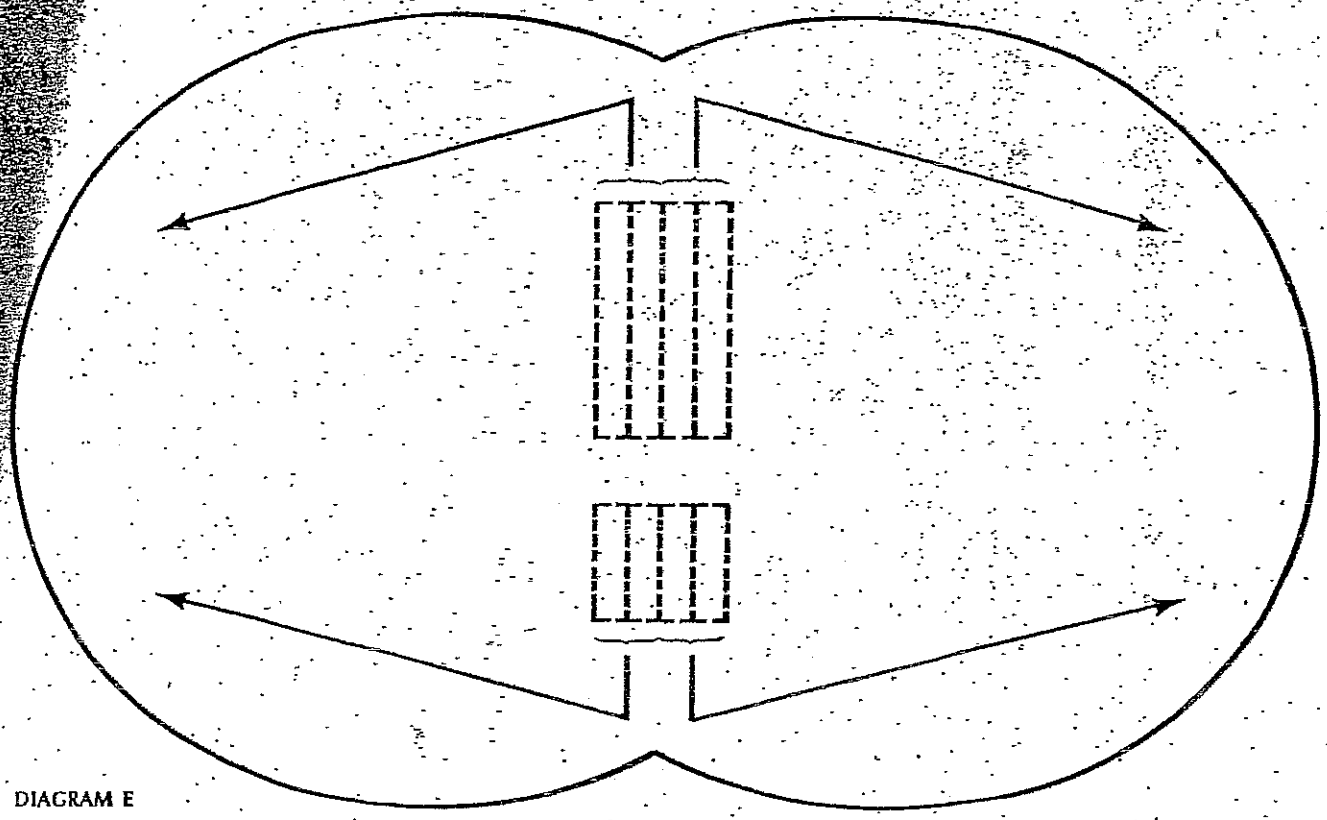

DIAGRAM E

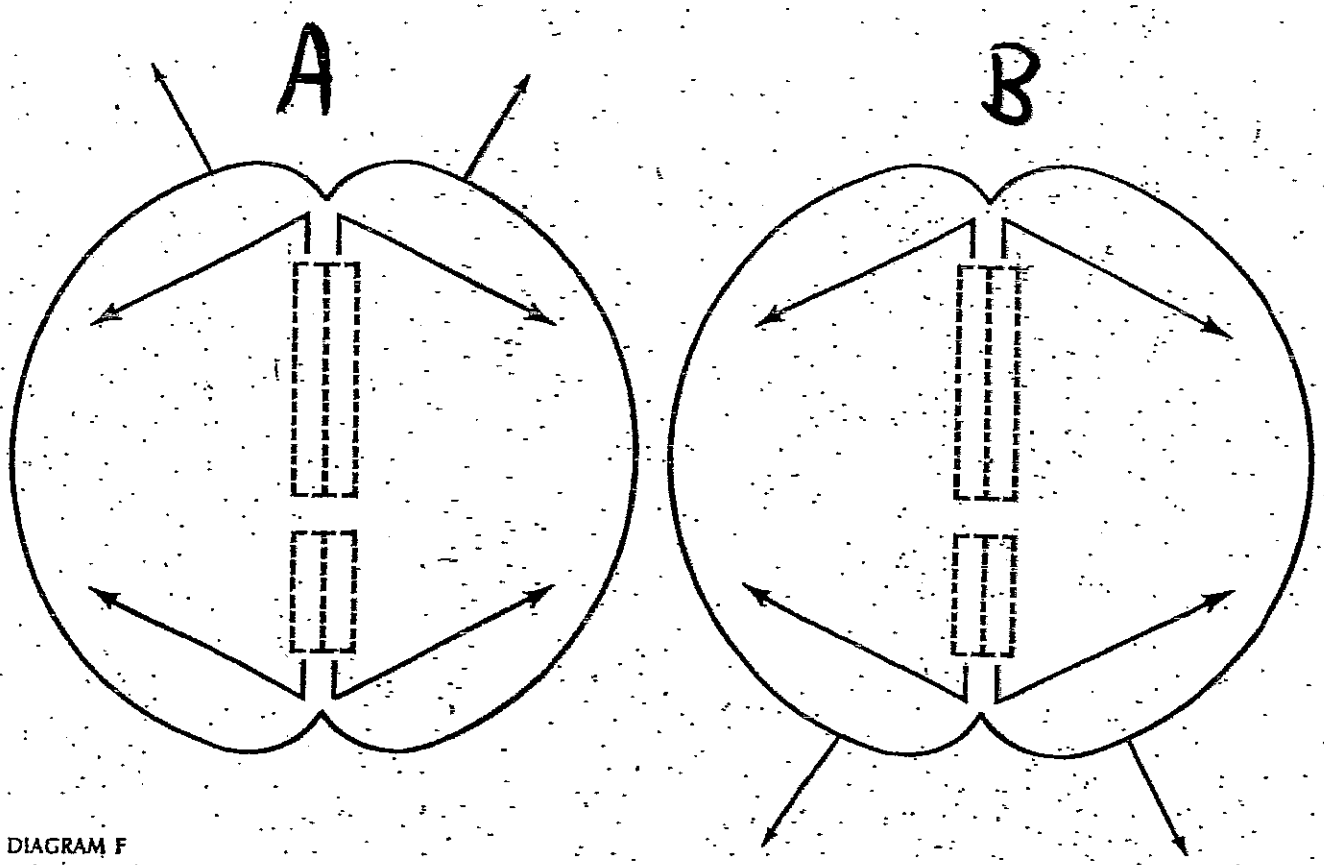

DIAGRAM F

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DIAGRAMS FOR INVESTIGATION 17, "COMPARING MITOSIS AND MEIOSIS"

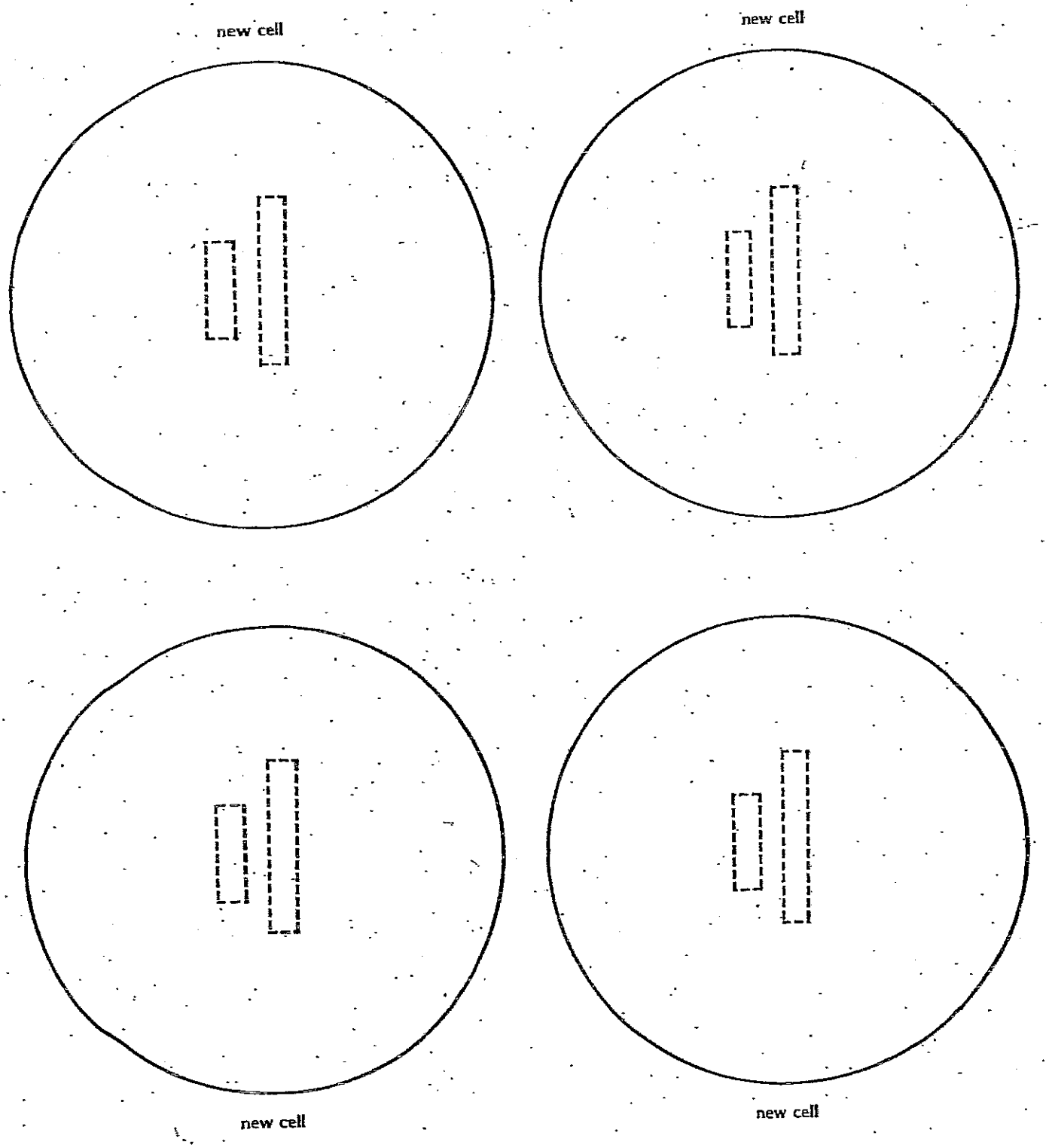

DIAGRAM G

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Name Date

The Menstrual Cycle

57

A number of stages or phases occur as the human female reproductive system prepares for egg fertilization. These stages are all under hormonal control. The entire cycle of stages usually takes about 28 days. However, as the last phase finishes, the first stage begins again. This process results in a cyclic pattern which repeats every 28 days. The cycle is called the menstrual cycle and occurs in human females once they reach puberty or sexual maturity. To aid in the study of this cycle, the menstrual cycle will be divided into 3 separate stages.

In this investigation you will

(a) study and graph changes occurring during the follicle stage of the menstrual cycle.
(b) study and graph changes occurring during the luteal (corpus luteum) stage of the menstrual cycle.
(c) study and graph changes occurring to the uterus during both the follicle and luteal stages of the menstrual cycle.

Materials

colored pencils

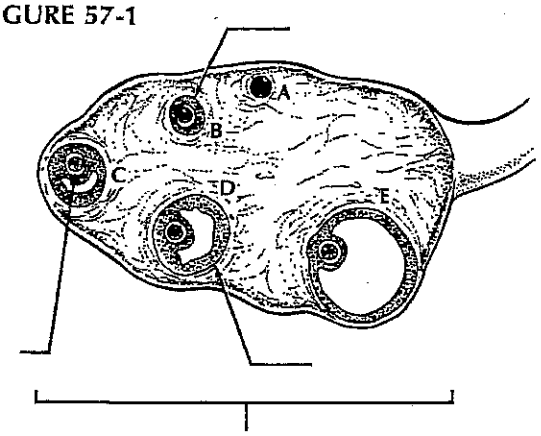
Procedure

Part A. Follicle Stage

Within the ovaries are located many egg cells. Each egg is enclosed within a structure called a follicle. The follicle is said to be immature. Under the influence of a hormone called FSH (follicle-stimulating hormone), the follicle matures.

Figure 57-1 shows the various stages of one follicle's maturation. An immature follicle is small in comparison to a mature follicle. The egg is shown within the follicle. The entire structure containing the follicles is an ovary. Keep in mind that one ovary contains many immature follicles.

FIGURE 57-1



• Label these structures on Figure 57-1: *egg, immature follicle, mature follicle, ovary.*

What directs a follicle to mature? A hormone called follicle stimulating hormone (FSH) is responsible. The amount of FSH in the bloodstream influences the changes just described. Table 57-1 shows data obtained from blood samples taken from a female and analyzed for the amount of FSH present in her body.

• Prepare a line graph of the data in Table 57-1. Use the graph marked Figure 57-2.

• Across the top of Figure 57-2, draw in the various stages of follicle maturation occurring at each letter. The drawings should match the letter stages

TABLE 57-1. AMOUNT OF FSH PRESENT

DAY	UNITS OF FSH	DAY	UNITS OF FSH
1	10	15	10
3	12	17	9
5	14	19	9
7	13	21	8
9	13	23	8
11	14	25	8
13	20	27	10

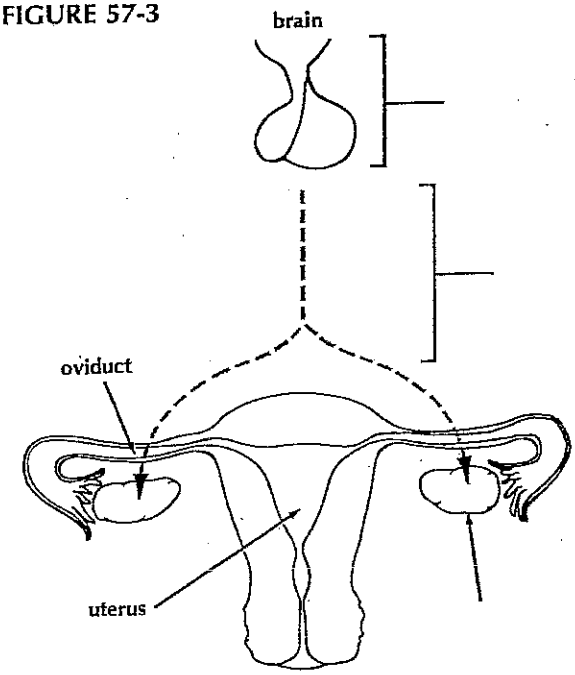
in Figure 57-1. Note the arrow across the top of the graph. This arrow shows that the events happen in a continuous cycle.

1. Starting with day 24 and going to day 13, how does the amount of FSH in the body appear to change? _____
2. Starting with day 24 and going to day 13, what happens to the follicle? _____
3. (a) What hormone is responsible for the changes in the follicle? _____
   (b) Why is this hormone correctly named? _____
4. During which days of the cycle is there the least amount of this hormone in the bloodstream? _____
5. What is happening to the next follicle at this time? _____
6. Events described so far are called the follicle phase. From start to finish, how many days in total does this phase take? _____

FSH is produced by a small gland at the base of the brain called the pituitary gland.

• Complete Figure 57-3 showing the relationship between the pituitary gland and ovary. Label the following parts: *FSH, ovary, pituitary gland.*

FIGURE 57-3



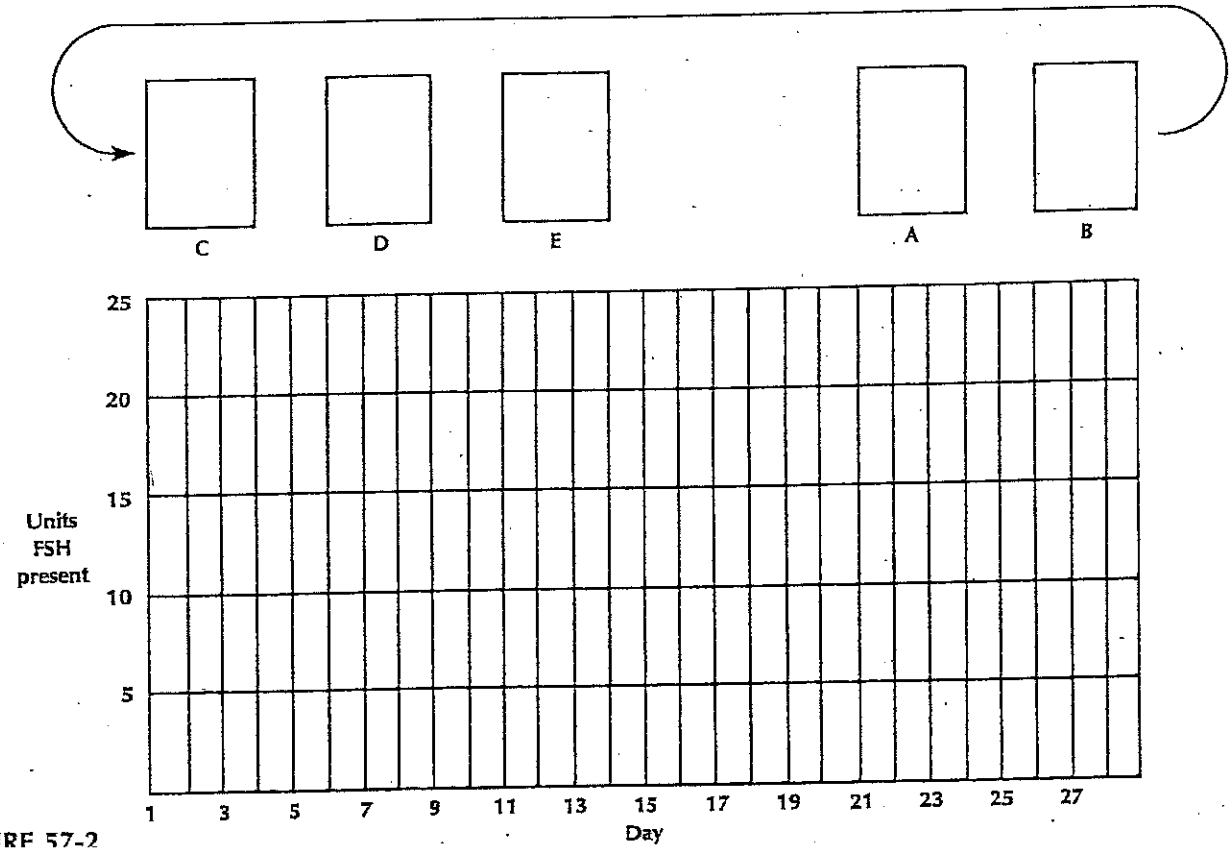


FIGURE 57-2

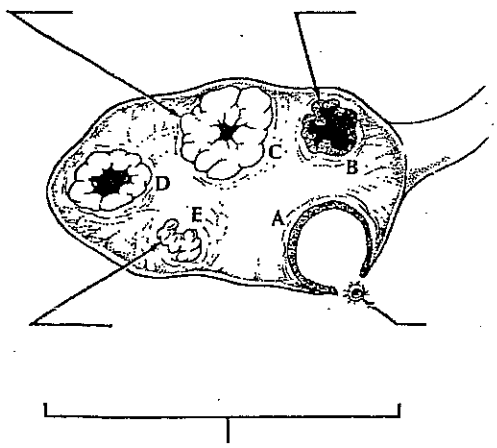
Name Date

Part B. Luteal Stage

Once a follicle is mature, it bursts open and the egg is released. The egg passes into the oviduct where it may or may not become fertilized. Meanwhile, the mature follicle, once it loses its egg, forms a body within the ovary called the corpus luteum.

Figure 57-4 shows the changes of the corpus luteum. A mature corpus luteum is rather large. After maturation, the corpus luteum begins to break apart and disappear.

FIGURE 57-4



- Label these structures in Figure 57-4: *newly formed corpus luteum, mature corpus luteum, disappearing corpus luteum, ovary, egg release.*

A hormone called luteinizing hormone (LH) is responsible for the changes in the corpus luteum. The amount of this hormone in the bloodstream influences the changes just described. LH is also produced by the pituitary gland.

Table 57-2 shows data obtained from blood samples taken from a female and analyzed for the amount of LH present.

- Prepare a line graph of the data from Table 57-2. Use the graph marked 57-5.

- Across the top of Figure 57-5, draw in the various stages of corpus luteum formation. The drawings should match the lettered stages in Figure 57-4.

TABLE 57-2. AMOUNT OF LH PRESENT

DAY	UNITS OF LH	DAY	UNITS OF LH
1	12	15	12
3	14	17	12
5	14	19	12
7	14	21	12
9	14	23	12
11	16	25	8
13	70	27	8

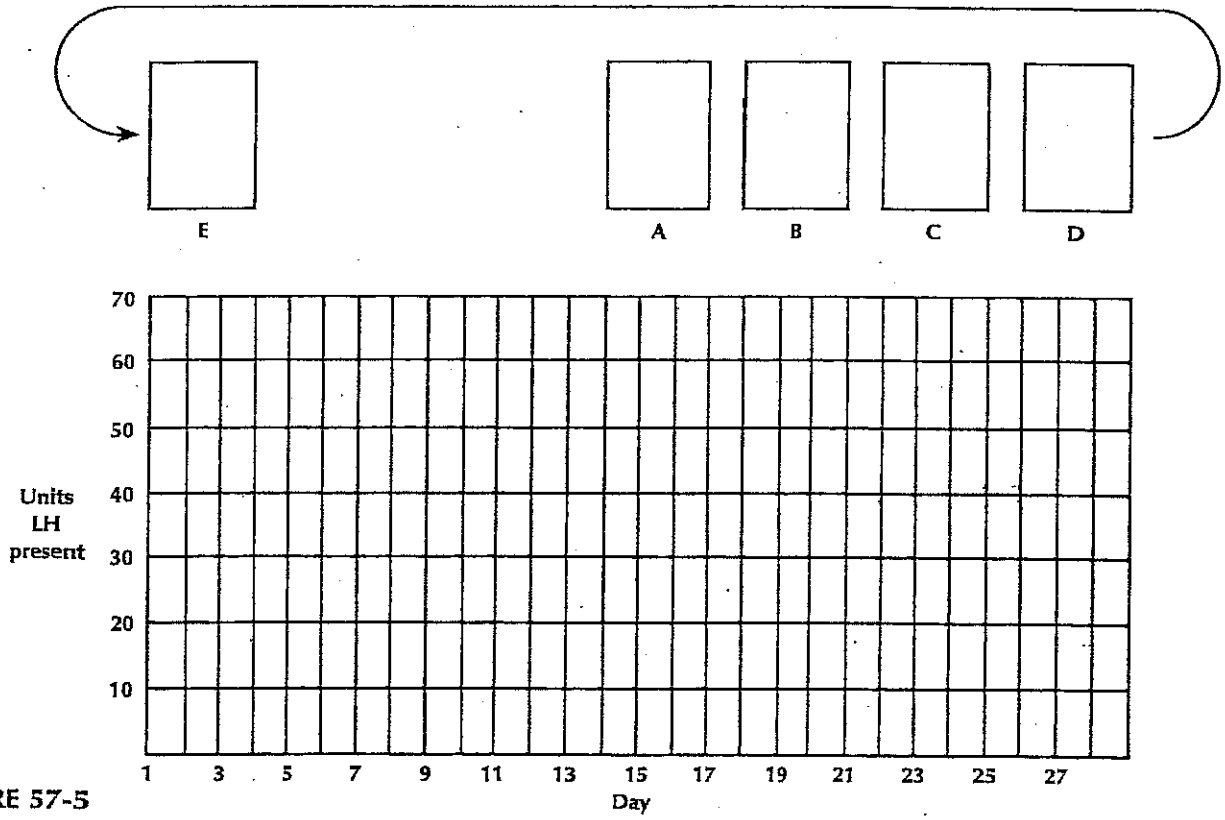


FIGURE 57-5

7. On what day does LH suddenly increase to its maximum amount? _____

8. What event occurs the next day? _____

9. (a) On day 15 through 23, how does the amount of LH change? _____
   (b) What is happening to the corpus luteum during this time? _____

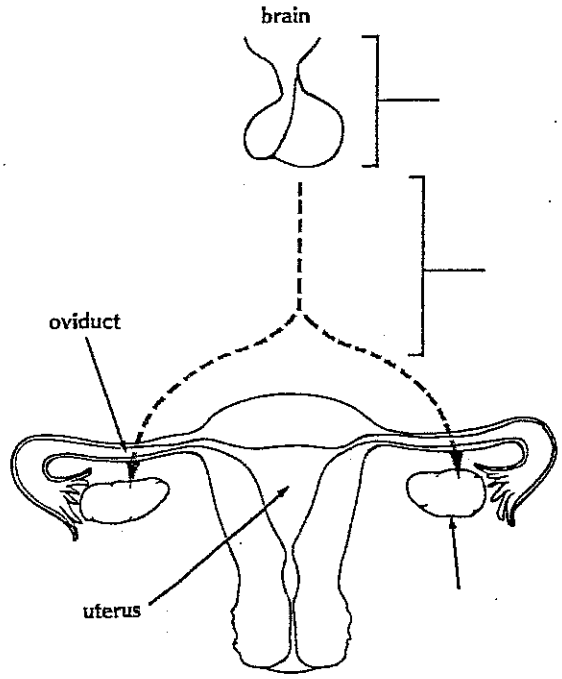
10. (a) During which days is LH at its lowest amount in the body? _____
    (b) What happens to the corpus luteum at this time? _____

11. (a) What is the full name of LH? _____
    (b) Why is LH correctly named? _____

12. Events described in this section are called the luteal stage. From start to finish, how many days in total does the luteal stage last? _____

• Complete Figure 57-6, labeling the following parts: *LH, ovary, pituitary gland.*

FIGURE 57-6



Part C. Changes in the Uterus

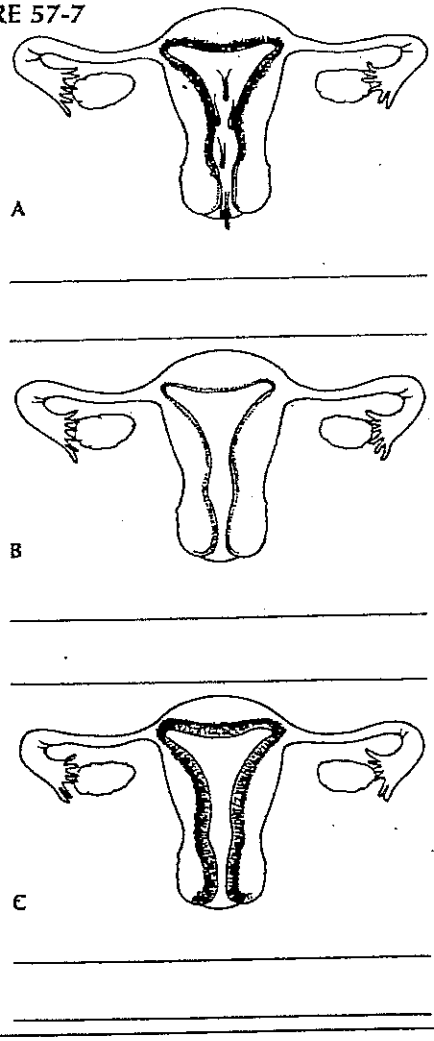
While the follicle and luteal stages are taking place in the ovaries, a series of changes is also occurring in the uterus. The uterus lining changes from being very thin to being very thick. This change in thickness occurs because the number of cells increases through rapid cell division. At one point the uterus ceases to thicken. The buildup of cells begins to break apart. This loss of uterine lining is called menstruation. It is accompanied by tissue loss as well as bleeding.

• Figure 57-7 shows several stages of uterus lining buildup. Label these structures: *thin uterus lining, menstruation, thick uterus lining.*

Two hormones are responsible for the thickening of the uterus. They are called estrogen and progesterone. The amount of these hormones in the bloodstream influences the changes just described.

Table 57-3 shows data obtained from blood samples taken from a female and analyzed for the amount of these hormones present.

FIGURE 57-7



Name _____ Date _____

TABLE 57-3. AMOUNT OF ESTROGEN AND PROGESTERONE PRESENT					
DAY	UNITS OF ESTROGEN	UNITS OF PROGESTERONE	DAY	UNITS OF ESTROGEN	UNITS OF PROGESTERONE
1	50	5	15	75	40
3	50	5	17	100	60
5	50	5	19	100	110
7	75	5	21	100	150
9	125	5	23	100	150
11	225	5	25	50	100
13	200	10	27	50	30

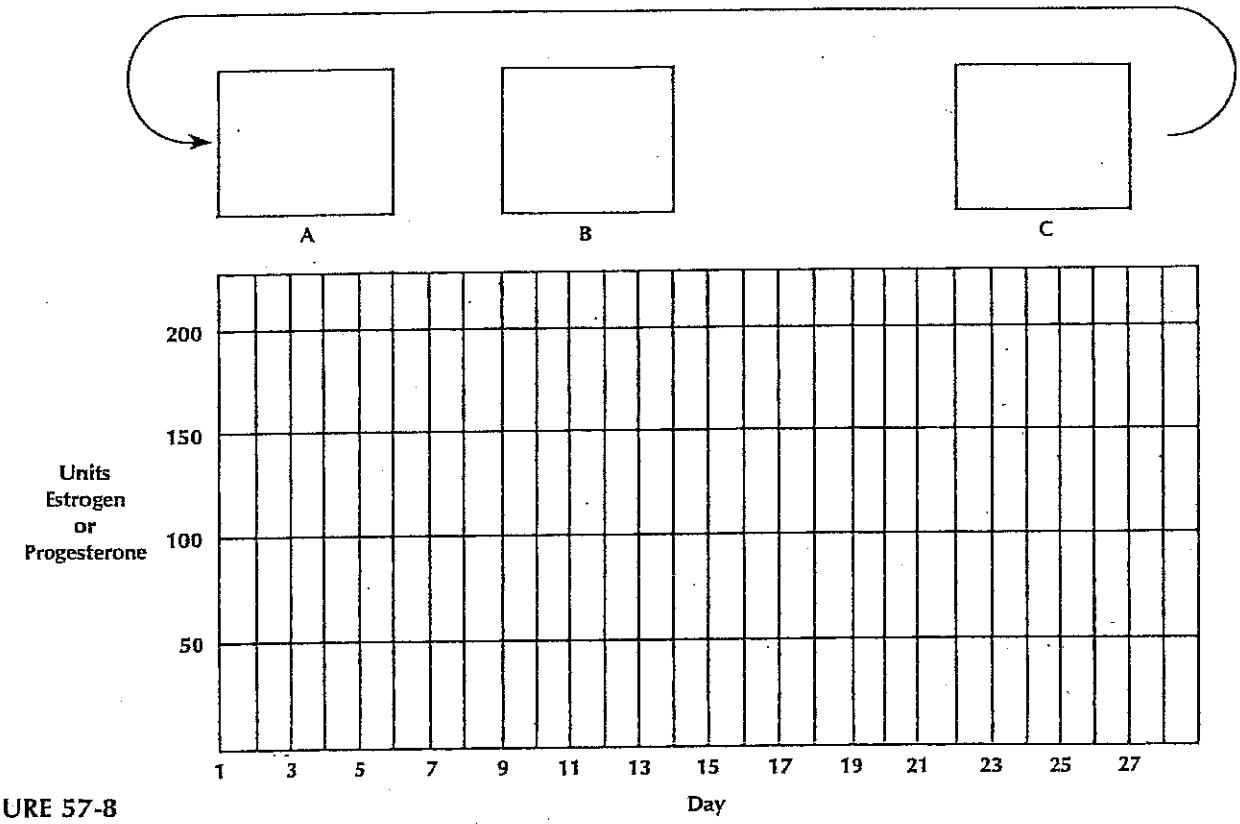


FIGURE 57-8

• Prepare a line graph of the data from Table 57-3. Use the graph marked Figure 57-8. Use a different colored line for each hormone and indicate on your graph which line represents which hormone.

• Across the top of Figure 57-8, draw the various stages of uterus thickness occurring at each letter. The drawings should match the lettered stages on Figure 57-7.

13. (a) Starting with day 5 and going to day 11, how does the amount of estrogen in the body change? _____
(b) What is occurring to the uterus during this time? _____

14. (a) Starting with day 13 and going to day 24, how does the amount of progesterone in the body change? _____
(b) What is happening to the uterus during this time? _____

15. Does it appear as if estrogen and progesterone are both bringing about similar changes in the uterus? _____

16. (a) During which days are the levels of progesterone and estrogen both at their lowest? _____
(b) What happens to the uterus at this time? _____

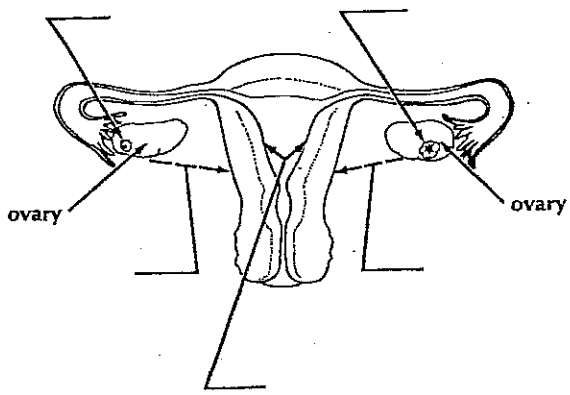
17. Do the days when a follicle is maturing (Figure 57-2) seem to best match when estrogen or progesterone is increasing? _____

18. Do the days when a corpus luteum is maturing (Figure 57-5) seem to best match the days when estrogen is increasing or when progesterone is increasing? _____

Estrogen is produced by the maturing follicle. Progesterone is produced by the corpus luteum.

• Complete Figure 57-9 showing the relationship among these reproductive structures. Label the following parts: *corpus luteum, estrogen, progesterone, maturing follicle, thickening uterus.*

FIGURE 57-9



Analysis

1. Name the two hormones produced by the pituitary gland. _____

2. (a) Name the two hormones produced by structures within the ovary. _____

   (b) What structures within the ovary are responsible for production of each hormone?

   _____

3. (a) Follicle maturation is controlled by what hormone? _____

   (b) Egg release is controlled by what hormone? _____

   (c) Corpus luteum development is controlled by what hormone? _____

4. (a) Summarize the events occurring during the follicle stage. _____

   _____

   (b) Summarize the events occurring during the luteal stage. _____

   _____

5. (a) Which two hormones control the thickening of the uterus? _____

   (b) Using Figure 57-8, which hormone is formed first in this phase of the cycle? _____

   (c) Using Figure 57-8, which hormone is formed last in this phase of the cycle? _____

   (d) Does one hormone tend to drop in amount while the other is increasing? _____

   On what days does this overlapping seem to occur? _____

6. Explain why the events described in this investigation are referred to as a cycle. _____

   _____

   _____

Name _____ Class _____ Period _____

24–2 How Do Internal and External Reproduction Compare?

Some animals that live in water gather in large groups during their breeding season. The females release their eggs into the water. The males of the species then release their sperm over the eggs. The sperm cells fertilize the eggs in the water. This is called external fertilization because it takes place outside the animal's body.

In other animals, the male releases sperm directly into the female's body where fertilization takes place. This is internal fertilization.

GOALS

In this exercise, you will:

a. interpret and chart data collected by a student.
b. determine if there is a relationship between the number of young produced, the type of fertilization, and the type of place where an animal lives.
c. determine how parental care helps the young.

KEYWORDS

Define the following keywords:

external fertilization _____

internal fertilization _____

parental care _____

MATERIALS

pencil

PROCEDURE

Part A. Observing Data On Animal Reproduction

Study the data in Table 1 below that was collected by a student.

Table 1.

Animal	Where Animal Lives	Number Of Young Produced	Number Of Young That Survive	Parental Care	
				Yes	No
Horse	land	1	1	X	
Spider	land	100	10	X	
Oyster	water	750,000	100		X
Jellyfish	water	1,000	10		X
Tiger Salamander	land	100	8		X
Starfish	water	1,500	5		X
Garter Snake	land	35	3	X	
Falcon	land	5	2	X	
Humpback Whale	water	1	1	X	
Clam	water	1,000,000	30		X

Part B. Using the Table

Use the data from Table 1 in Part A to complete Table 2.

1. Look at Table 1 to find where each animal lives.
2. Look at the number of young produced by each animal in Table 1 and decide if fertilization is internal or external. Hint: If the young produced are greater than 150, then fertilization is usually external.

Table 2.

Lives in Water		Lives on land	
Fertilization		Fertilization	
Internal	External	Internal	External

Part C. Applying The Use of Data

1. Look at Table 3. It gives data on reproduction for another list of animals.
2. Using what you have learned from Parts A and B, complete the information in Table 3 under the columns C and D.

Table 3.

A Animal	B Number Of Young Produced	C Fertilization		D Where Animal Lives	
		Internal	External	Land	Water
Bluegill	15,000				
Chameleon	8				
Leech	60				
Lobster	8,500	X			
Rainbow Trout	4,000				
Crayfish	40				
Lizard	10				
Cow	1				
Blue Crab	950,000	X			
Toad	10,000				

Name _____ Class _____ Period _____

Part D. Using Data to Draw Conclusions

Using what you have learned from Parts A, B, and C, fill in Table 4 to show if an animal gives parental care or not.

Table 4.

Animal	Number Of Young Produced	Number Of Young That Survived	Parental Care	
			Yes	No
Opossum	10	8		
Grasshopper	300	14		
Carp	12,000	22		
Deer	1	1		
Pig	8	6		

QUESTIONS

1. What kind of fertilization do animals that live in water usually show? _____
2. Where do most of the animals live that show internal fertilization? _____
3. What is an animal that has internal fertilization and lives in water? _____
4. Do animals that fertilize their eggs internally produce more or less young than animals that fertilize their eggs externally? _____
5. Which eggs do you think have a better change of being fertilized, those that are fertilized internally or those fertilized externally? _____
6. Freshwater clams produce 20 young a breeding season; some freshwater jellyfish produce 500 young. Which animal do you think has internal fertilization? Why? _____
7. Do most of the animals that provide parental care have many or few young? _____
8. Where do most animals live that give no parental care for their young? _____
9. From Tables 1, 3, and 4 how can you tell which young animals have a better chance of surviving? _____
10. In Table 3 of Part C, which of the animals do not fit the pattern between numbers of offspring and kind of fertilization as seen in Part A? Explain. _____

11. Which of the animals do you think have the best chance of survival? Why?

_____

_____

12. The bluegill sunfish cares for its eggs and young while the rainbow trout does not. Which would probably have a greater number of young survive to reproduce? Explain. _____

13. Write a short paragraph that explains each of the following points:

a. The type of fertilization of an animal is different between animals that live on land and those that live in water. _____

_____

b. The number of eggs produced by an animal is different between animals that have internal fertilization and those that have external fertilization.

_____

_____

c. The number of young that survive differs between animals that have internal fertilization and those that have external fertilization. _____

_____

_____

d. The number of young that survive differs between animals that give parental care and those that do not. _____

_____

_____

Pregnancy

Part 1

Shade the walls of the uterus, marked **a**, in red. Cut out round the body line and across the dotted lines. Paste the back and stick into the centre of the page in your neat book.

Part 2

Shade the baby pink except for its hair which you can shade brown or black. Cut round the outline.

Part 3

Along the length of the cord draw one red line and one blue. At end **Y** make both the artery and vein split into several arteries and veins (like a river delta). Shade the rest of the cord in pencil. Cut out and paste the back of the tip of end **X** and stick this on to the stomach of the baby over the mark **X**.

Part 4

Cut out this shape. Take a polythene bag and using the polythene double thickness, cut out the shape of Part 4. Starting at **Z** sew with a small running stitch round the edge of the polythene in direction of arrow.

When you are half way round slip the baby into the bag you are sewing so that the cord comes out by the mark **Z**. Finish sewing the baby into the bag.

Part 5

Shade this orange. Cut it out. Paste the back and stick on to the dotted area of Part 1. Paste the back of end **Y** of Part 3 and stick on to the **Y** of this part. Bend the cord so that the baby, in its bag, fits neatly into the uterus head downwards.

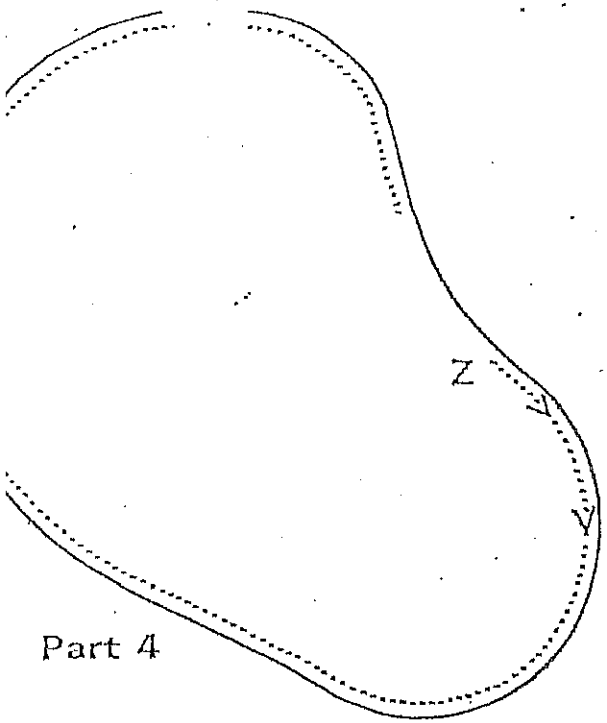
Part 6

Colour this red. Cut it out. Paste a small patch at the back of the dotted end and stick into your book so that the baby is completely covered.

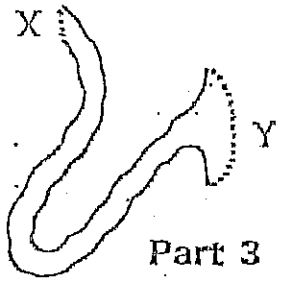
Make your key of the following, shading in the appropriate colours.

Thick lining of the uterus
~~Space inside the uterus~~
Uterus
cervix
amnion
ventral abdomen

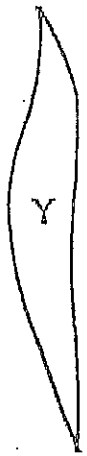
Placenta
~~Cord~~
~~Ring of water~~
Fetus
Umbilical Cord
Vagina



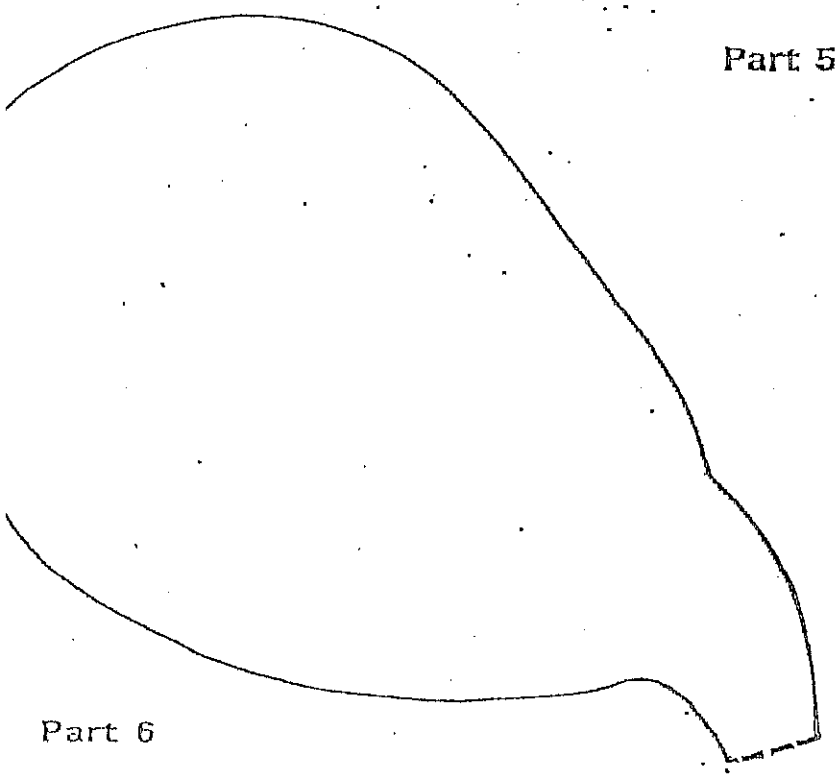
Part 4



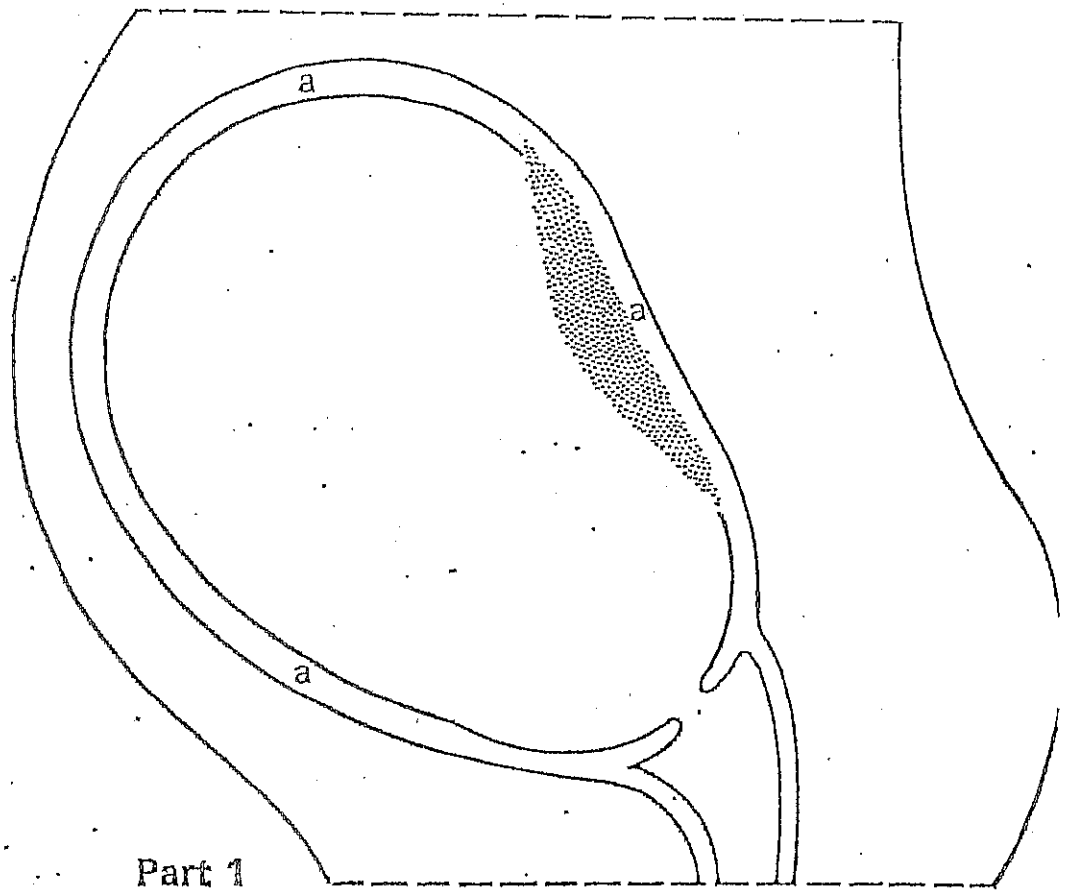
Part 3



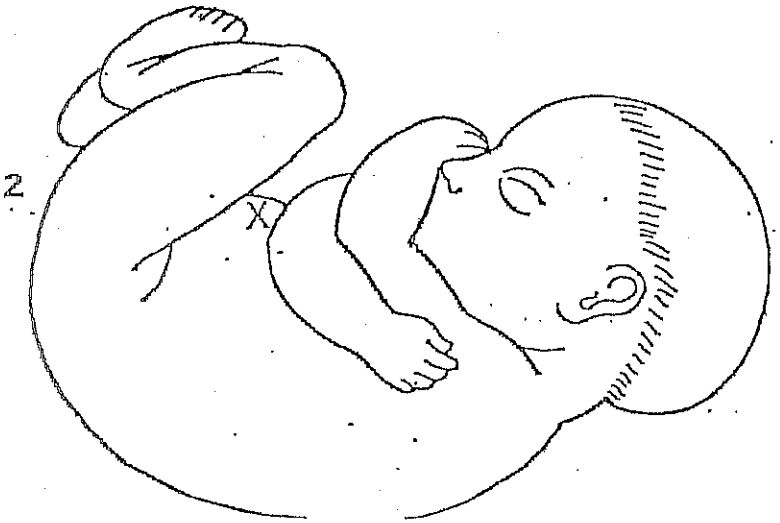
Part 5



Part 6



Part 1



Part 2

Name _____ Class _____ Period _____

How Does a Human Fetus Change During Development?

Development in a human takes about 38 weeks. Many changes take place with the fetus during that time. Two changes that do occur are increases in size and mass. How much of a change in mass and size takes place each week?

GOALS

In this activity, you will:

a. measure the length of diagrams of the human fetus.
b. graph the length and mass of a human fetus.
c. determine when during development most changes in mass and size occur.

KEYWORDS

Define the following keywords:

development _____

embryo _____

fetus _____

mass _____

premature _____

MATERIALS

metric ruler

PROCEDURE

Part A. Development of a Human Fetus

1. Look at Figure 1. It shows six stages of a developing human fetus. They are shown at 40% of their natural size.
2. Follow the steps outlined below to measure the total length of each stage. Use the metric ruler and measure in millimeters. Use the 38-week stage as a guide and record your data in the spaces provided in Table 1.
   a. Measure the body length from the rump to the top of the head.
   b. Measure the thigh length from the rump to the knee.
   c. Measure the length of the leg from the knee to the foot.
4. Add all three measurements together and record the total in the space provided in Table 1.
5. Multiply the total by 2.5 to give a figure that is close to the actual size of the fetus at each stage.
6. Record this actual size in the table.

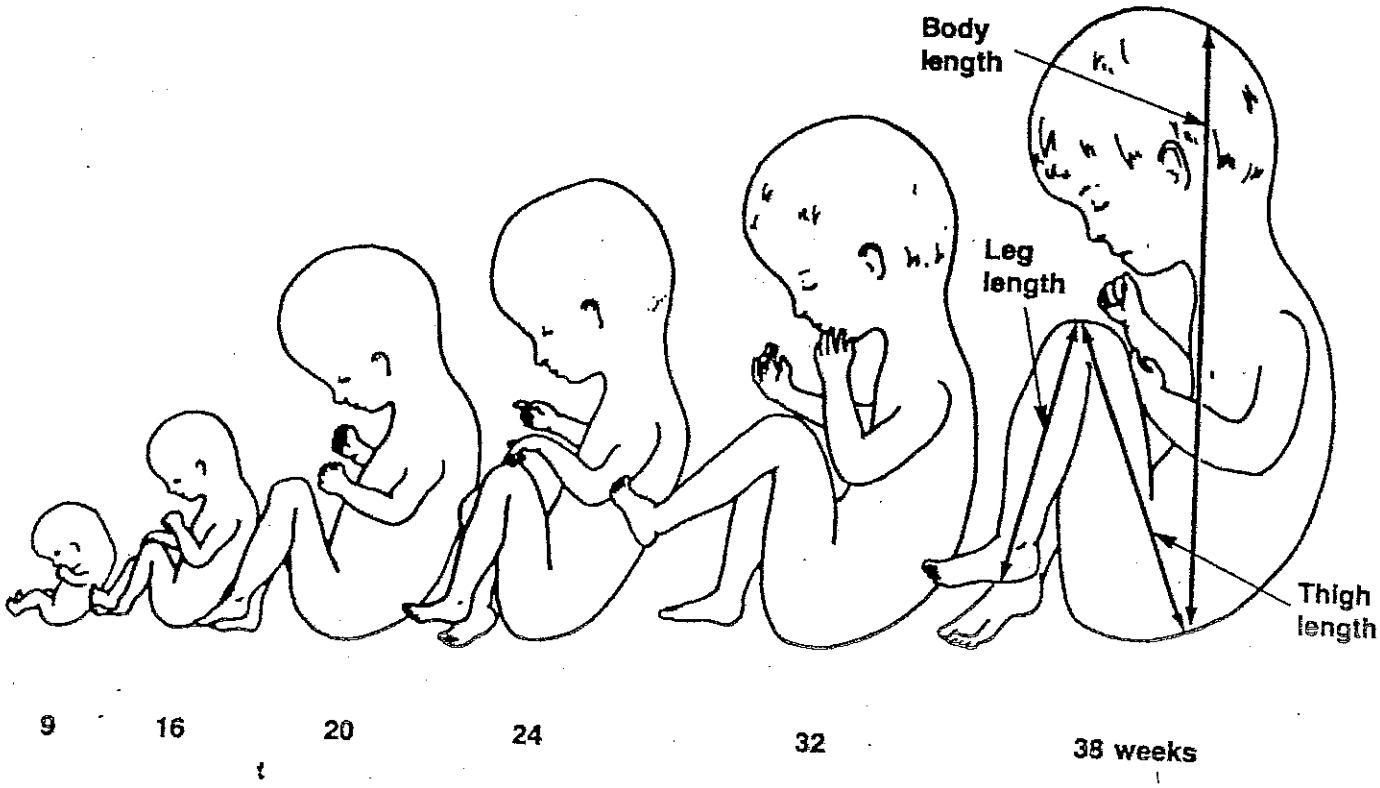


FIGURE 1. Stages in the development of a human fetus

Table 1. Lengths of a Developing Fetus

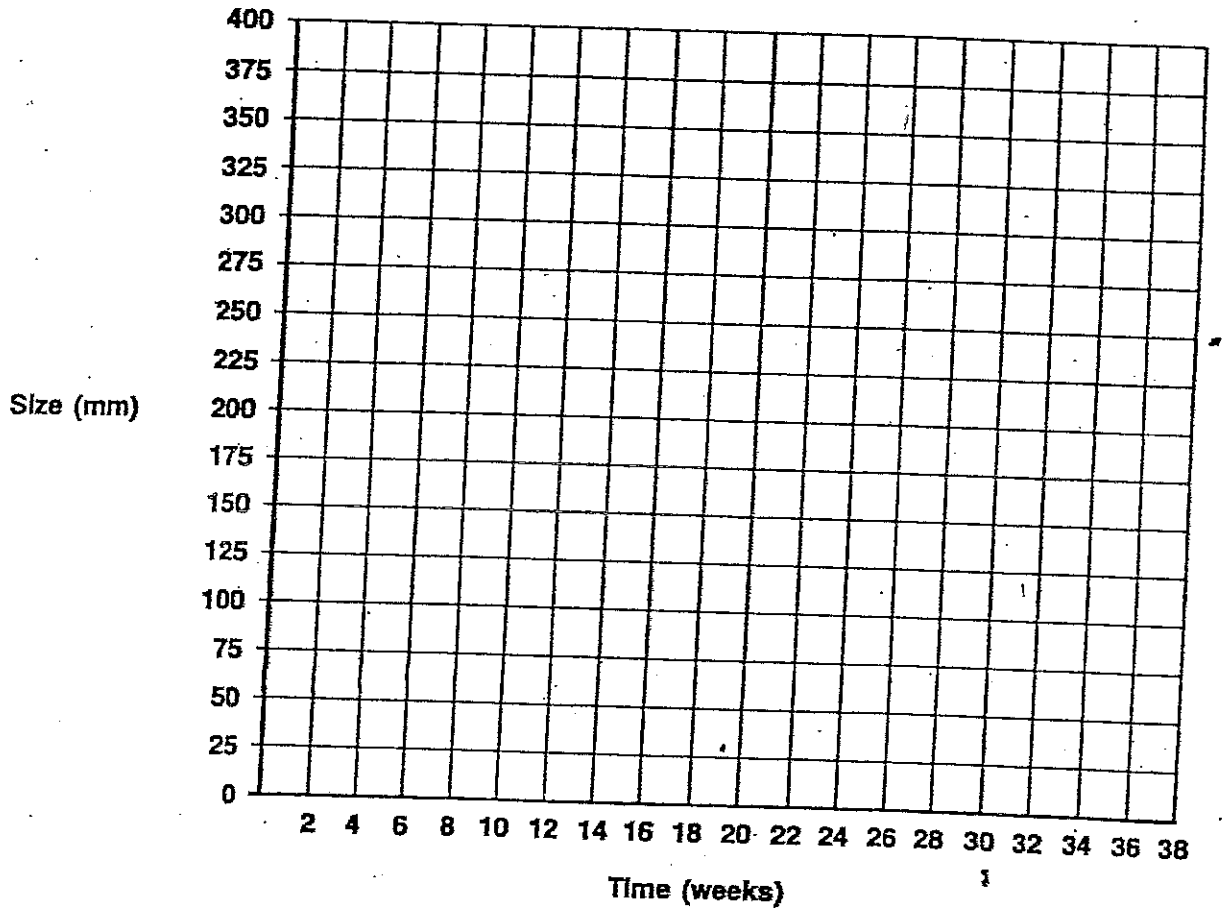
Age of fetus in weeks	Body length	+	Thigh length	+	Leg length	=	Total length	× 2.5 =	Actual length
2									
9									
16									
20									
24									
32									
38									

Part B. Plotting Length of a Developing Fetus

1. Plot the data from Table 1 onto the graph in Figure 2.
2. Plot the actual fetal length against the age of the fetus. Notice that the length of the fetus at week 2 has already been plotted.

Name _____ Class _____ Period _____

FIGURE 2. Length of a developing fetus



Part C. Plotting Mass of a Developing Fetus

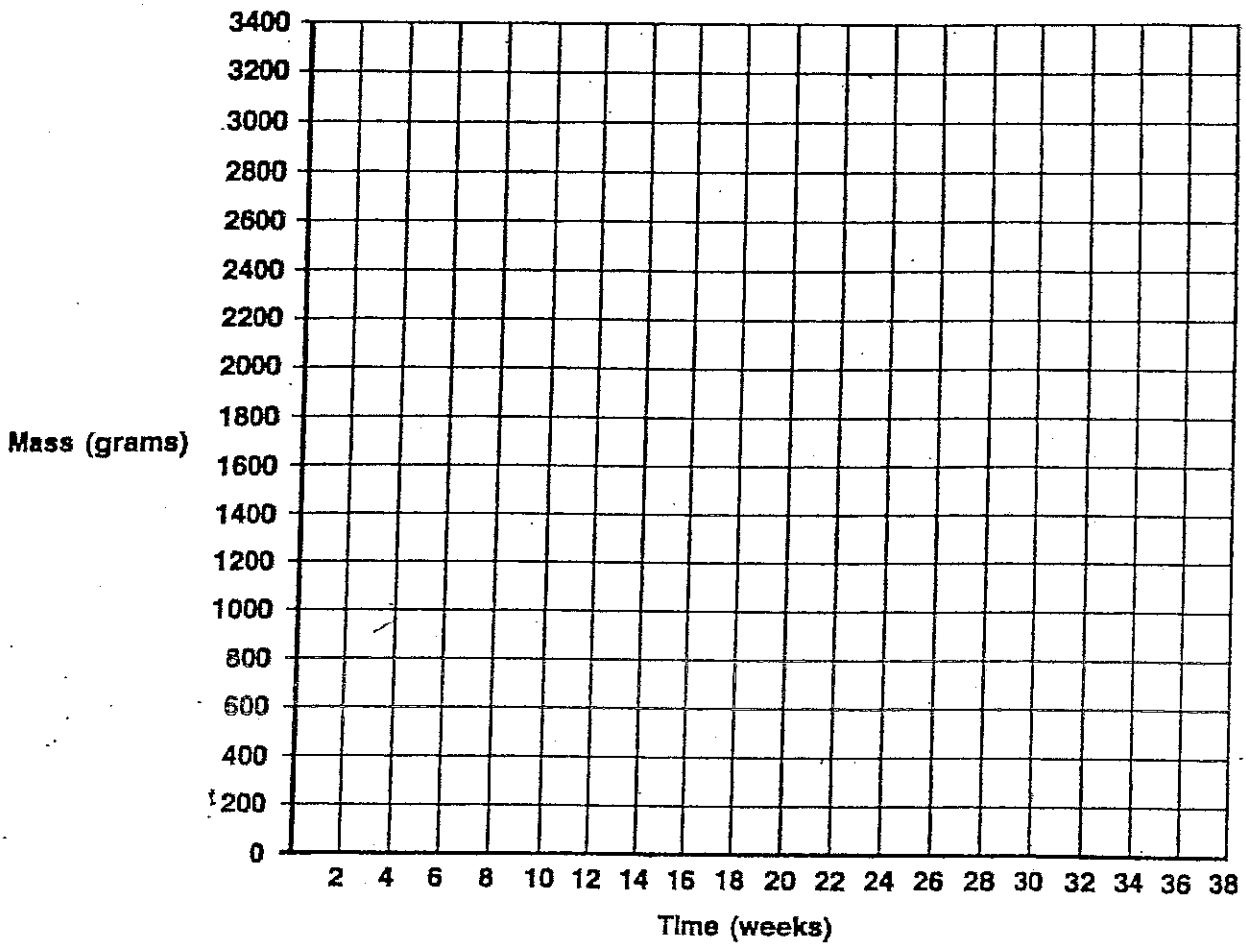
1. Look at the data supplied in Table 2.
2. Plot the data of the developing fetus from Table 2 onto the graph in Figure 3.
3. Plot the mass of the fetus against the age of the fetus.

Table 2. Mass of a Developing Fetus

Time (weeks)	Mass (grams)	Time (weeks)	Mass (grams)
4	0.5	24	650
8	1	28	1100
12	15	32	1700
16	100	36	2400
20	300	38	3300

255

FIGURE 3. Mass of a developing fetus



QUESTIONS

1. During what weeks of development is the human baby called an embryo?

_____

2. What is the length of an embryo during this time?_____

3. How much mass does an embryo gain during this time?_____

4. During what weeks of development is the human baby called a fetus?_____

_____

5. Look at Figures 2 and 3 for the halfway point in development at week 19.

   a. Is the fetus half of its full length at this time?_____

   b. Is the fetus half of its full mass at this time?_____

6. a. At what week does the fetus reach half its full length?_____

   b. At what week does the fetus reach half its full mass?_____

7. If a premature baby is born with a mass of

   a. 2200 grams, how old is the fetus?_____

   b. 1800 grams, how old is the fetus?_____

Name _____ Class _____ Period _____ 256.

25–2 What Changes Occur During Birth?

A human baby develops for about 38 weeks inside the mother. Then labor begins and the baby is born. What changes take place during and after birth? Why must a doctor sometimes have to perform a caesarean operation to help in delivery?

GOALS

In this activity, you will:

a. compare the changes that occur during birth.
b. learn why a caesarean delivery may be needed.
c. compare a delivery through the birth canal with a caesarean delivery.

KEYWORDS

Define the following keywords:

caesarean _____

contractions _____

fetus _____

labor _____

placenta _____

uterus _____

MATERIALS

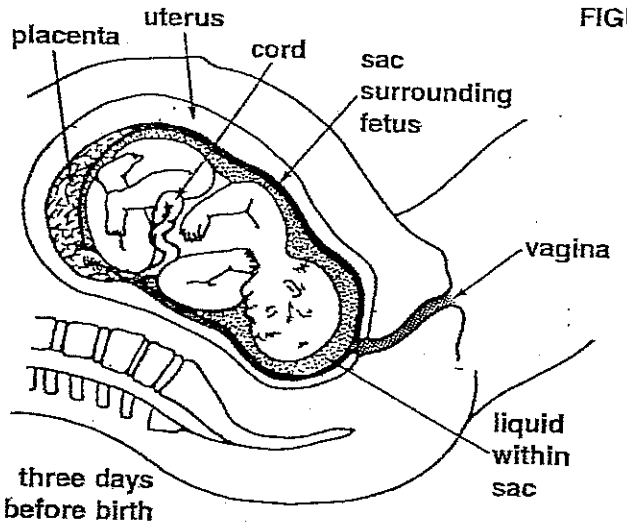
metric ruler

PROCEDURE

Part A. Stages of Birth

1. Look at the diagrams of four stages of birth shown in Figures 1 and 2.

FIGURE 1.



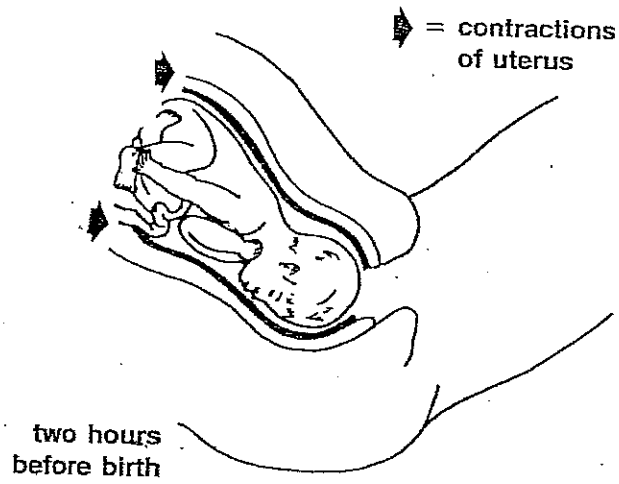
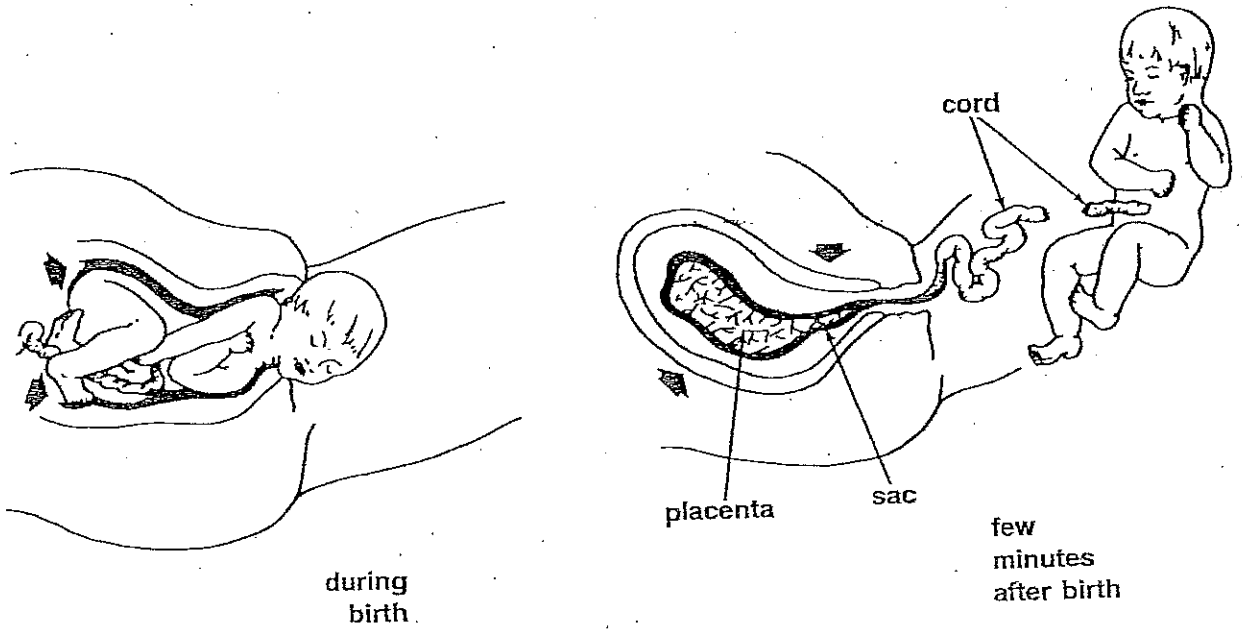


FIGURE 2.



2. Answer *yes* or *no* to each of the following questions in Table 1.

Table 1. Stages During Birth

	Three days before birth	Two hours before birth	During birth	Few minutes after birth
Is baby inside the uterus?				
Is baby inside the vagina?				
Is baby outside the mother's body?				
Is baby inside the sac?				
Has the sac broken?				
Are contractions occurring?				
Is baby attached to the cord?				
Is the cord attached to the placenta?				
Is the placenta attached to the uterus?				
Is the placenta being pushed out?				
Has the vagina opened?				
Is baby attached to the mother?				
Has liquid been lost from the sac?				
Is baby still dependent on the mother?				

Name _____ Class _____ Period _____

Part B. What Is a Caesarean Birth?

1. Look at the diagram in Figure 3 that shows the outline of the pelvis and the head of a fetus just before the time of birth.
2. Note carefully that the head must be able to pass through the opening in the pelvis during birth.
3. Measure line a. This represents the width of the opening in the pelvis.
4. Measure line b. This represents the width of the head of the fetus.

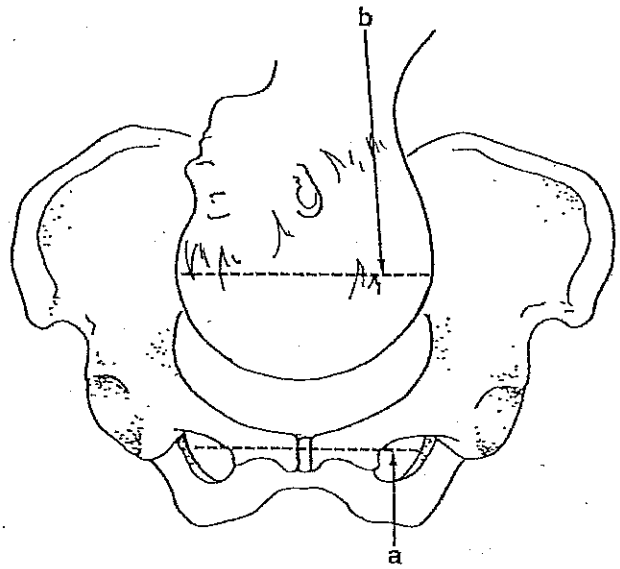


FIGURE 3. Sizes of pelvis and head of fetus

5. Record your data in millimeters here:

   a. width of pelvis opening _____

   b. width of fetus head _____

6. Notice that this fetus would not be able to pass through this pelvis opening.
7. A caesarean operation must be done to deliver the baby.
8. Look at how a caesarean birth is done in Figure 4. This is usually done before the mother goes into labor.
9. To compare a birth canal delivery with a caesarean delivery, answer the questions in Table 2.

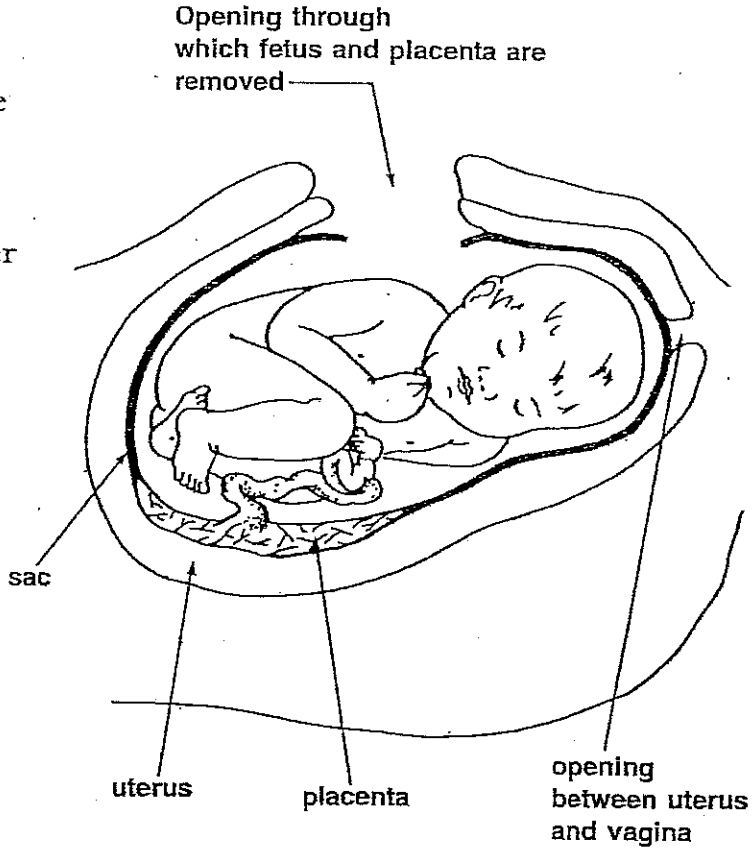


FIGURE 4. Caesarean birth

Table 2. Comparing a Caesarean Delivery With a Birth Canal Delivery

Trait	Birth canal	Caesarean
Does the fetus pass through opening in the pelvis?		
Does the fetus pass through the vagina?		
Does the placenta move through the vagina?		
Is the fetus lifted from the uterus?		
Is the uterus cut open?		
Is the sac cut open?		
Must the cord be cut to separate the fetus from the placenta?		
Do contractions occur?		

QUESTIONS

1. What two body parts surround and protect the fetus as it develops?

_____

2. What is the job of the placenta? _____

_____

3. What is the job of the cord? _____

4. What is meant by the word *labor*? _____

_____

5. The placenta is sometimes called the *afterbirth*. Why is this a good name for this part? _____

6. List several changes that take place several hours before birth. _____

_____

7. List several changes that take place a few minutes after birth.

_____

_____

_____

NAME _____ DATE _____

PARTNER _____ TEACHER _____

Human Inheritance

BACKGROUND: With an understanding of heredity and probability, biologists have learned about the genetics of many human traits. In many of these traits, several pairs of genes are involved and the pattern of inheritance is complex. For this activity we will assume that the traits we are studying are regulated by the alleles of only one gene, with one allele from the father and one from the mother.

OBJECTIVES: In this activity you will:

1. Determine your phenotype for several traits.
2. Determine (as far as possible) your genotype for the same traits.
3. Interpret the genotypes of individuals in a pedigree.

PROCEDURES AND OBSERVATIONS

Part I. Phenotypes and Genotypes of Common Traits

You will determine your phenotype and try to determine your genotype for the traits listed in Table 1 on the following page. Remember, if you show a dominant trait, you may be homozygous or heterozygous for that trait. Suppose however, that one of your parents shows the recessive trait. In that case, the parent would have passed on a gene for the recessive trait and you would be heterozygous for that trait. If neither of your parents shows the recessive trait, you may not know whether you are heterozygous or homozygous for the trait. In this case, put a blank (_) for the unknown allele. If you show the recessive trait, record it as the phenotype as well as the genotype, with two recessive alleles.

Free earlobes, *L*, are dominant. People whose earlobes are attached directly to the side of the head have the recessive genotype, *ll*.

1. Have your partner check your earlobes. Record your phenotype and genotype in Table 1 on the next page. (If you cannot determine whether your genotype is homozygous dominant or heterozygous, record L_ in the table.)

Inheritance of eye color is controlled by multiple genes, but people having the homozygous recessive genotype, *bb*, have blue eyes. People who have a dominant allele, *B*, may have different shades of brown, hazel, or green eyes.

2. Check your eye color. Record your phenotype and genotype in Table 1 on the following page.

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Table 1. Phenotypes and Genotypes of Some Human Traits

Trait and Symbols for Genes	Phenotype	Genotype
Shape of ear lobe *L, l*		
Eye color *B, b*		
Shape of hairline *W, w*		
Ability to roll tongue *R, r*		
Ability to fold tongue *T, t*		
Shape of little finger *F, f*		
Ability to taste PTC *A, a*		
Hair on middle joint of fingers *H, h*		
Hair color *N, n*		
Hair curliness *C, c*		
Eyelash length *S, s*		

A widow's peak is a hairline that forms a downward point in the middle of the orehead. This is caused by a dominant allele, *W*. A smooth hairline is caused by the ecessive genotype *ww*.

). Have your partner check your hairline. Record your phenotype and genotype in Table 1.

A dominant allele, *R*, gives some people the ability to roll their tongues into a "U" shape when it is extended. People with the recessive alleles *rr*, cannot roll their tongues.

4. Check to see if you can roll your tongue. Record your phenotype and genotype.

A dominant allele, *T*, gives some people the ability to fold their tongues over. People with the recessive genotype, *tt*, cannot.

5. Check to see if you can fold your tongue. Record your phenotype and genotype.

A dominant allele, *F*, results in the end joint of the little finger of each hand bending inward. Straight little fingers are a result of the recessive genotype *ff*.

6. Place your hands on a flat surface, palms down, and relax. Check to see if the first joints of your little fingers are bent or straight. Record your phenotype and genotype.

Individuals who can taste the bitter chemical phenylthiocarbamide, PTC, have at least one dominant allele, *A*. Those with the recessive genotype, *aa*, cannot taste it.

7. Taste PTC paper to find out if it tastes bitter to you. Record your phenotype and genotype in Table 1.

Individuals who have hair on the middle joints of their fingers have at least one dominant allele, *H*. Those with two recessive alleles, *hh*, do not have hair on that joint.

8. Check to see if you have hair on the middle joints of your fingers. Record your phenotype and genotype in Table 1.

Individuals with red hair have the recessive genotype *nn*. Those with any other color hair have at least one dominant allele, *N*.

9. Check your hair-color. Record your phenotype and genotype in Table 1.

Individuals having curly hair have at least one dominant allele, *C*. People having straight hair have the recessive genotype *cc*.

10. Check your hair type. Record your phenotype and genotype in Table 1.

Long eyelashes are the result of the dominant allele *S*. Short eyelashes are the result of the recessive genotype *ss*.

11. Have your partner check your eyelashes. Record your phenotype and genotype.

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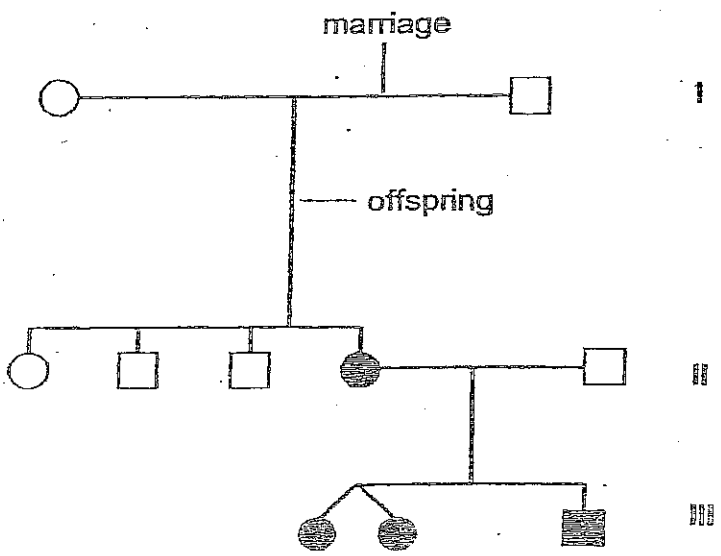
Part 2:. Human Pedigree

A diagram showing the transmission of a trait through several generations of a family is called a *pedigree*. In Figure1, generation I is made up of grandparents, generation II is their children, and generation III is their grandchildren.

1. Study the pedigree diagram and the key in Figure 1 to learn the symbols.

Symbol	Meaning
○	Female without trait
□	Male without trait
●	Female with trait
■	Male with trait
•	Female, died in infancy
▪	Male, died in infancy
△	Identical twins

Figure 1



Individuals who lack an enzyme needed to form the skin pigment melanin are called *albinos*. Normal skin pigmentation is dominant.

2. Use *D* to represent the allele for normal skin and *dd* to represent the genotype for albinism. Where you cannot be sure whether an individual with the dominant trait is heterozygous or homozygous, show the genotype as *D_*.

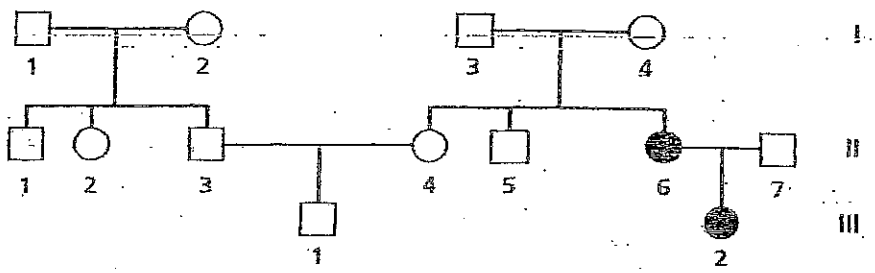
3. List the genotype of each individual in Figure 2 in the table on the next page.

4. Use *A* to represent the allele for the ability to taste PTC, a dominant allele. Use *aa* for the PTC non taster who exhibits the recessive trait. Use *A_* where the genotype is uncertain.

5. List the genotypes of each individual in Figure 3 in the table on the next page.

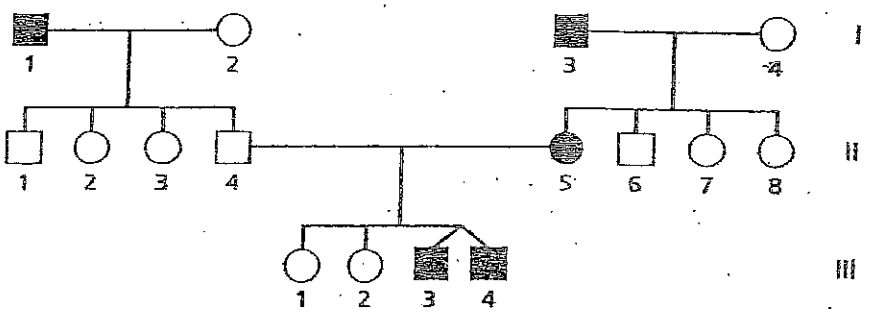
Individual	Genotype
I 1	
2	
3	
4	
II 1	
2	
3	
4	
5	
6	
7	
III 1	
2	

Figure 2



Individual	Genotype
I 1	
2	
3	
4	
II 1	
2	
3	
4	
5	
6	
7	
8	
III 1	
2	
3	
4	

Figure 3



ANALYSIS:

1. Do you think that anyone in the class has all the same traits that you have? Why?

2. In the pedigree in Figure 2, if individuals 6 and 7 have another child, what is the chance that it will be an albino?

3. In Figure 2, can you determine the genotypes of individuals 1 and 2 in generation I? Explain.

4. In the pedigree diagram in Figure 3, if individuals 4 and 5 in generation II have another child, what is the probability that it will be a taster?

5. In Figure 3, if individual 8 in generation II married a man with genotype AA, what is the probability that she will have a non taster child? Illustrate your reasoning with a Punnett square.

CONCLUSION:

Explain the difference between the information obtained with a Punnett square and that obtained from a pedigree.

Is the dominant trait necessarily the most common? Use the information obtained in Part 1 to explain and support your answer.

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GENETICS: MAKING YOUR OWN CHILD

NAME: _____

TEACHER: _____

PERIOD: _____

DATE: _____

DUE DATE: _____

NAME: _____ DATE: _____

HAVING A CHILD OF YOUR OWN IN JUST ONE SCIENCE CLASS

LAB # _ 27 _

INTRODUCTION: The Austrian monk, Gregor Mendel, determined the basic laws of genetics, the rules governing how traits are handed down from parent to offspring. A trait is passed down through genes, the basic unit of genetic information, with at least two genes, one from each parent, controlling its inheritance. Some traits are dominant, that is they prevent other traits from appearing. Some are recessive, these do not appear when a dominant gene is present.
For example, let us say that "tallness" is a dominant trait, and "shortness" recessive. The following diagram, called a Punnett Square, show what might happen when a plant with two tall genes (a pure tall) is crossed with a plant with two short genes (a pure short).

T = tall
s = short

	T pure tall	T
s pure short	Ts	Ts
s	Ts	Ts

All the offspring would be hybrids, that is contain both a dominant and a recessive gene. Since we have determined that tallness is dominant, all offspring would look tall. But if we crossed these hybrids, we could get more varied results in the third generation as the following Punnett Square shows.

T = tall
s = short

	T hybrid	s
T hybrid	TT	Ts
s	Ts	ss

It is important to note that the diagram holds true only when large numbers of offspring are represented. In this demonstration, we are going to discover what an offspring might look like if each parent is a hybrid for each characteristic and examine the possible variation that may result.

PROCEDURE:

1. You and your partner will be the father and mother of your offspring. In each coin toss, HEADS will stand for the DOMINANT gene and TAILS will represent the recessive gene.

2. Select an appropriate name for your child.
3. Flip the coin to determine the sex of your child. Since the father determines the sex of the offspring, only the father will flip the coin. HEADS is a boy; TAILS is a girl.
4. Use the coin to determine the genetic makeup of your child. Place your data in the data table. Use an upper case letter for a dominant toss and a lower case letter for a recessive toss. Each characteristic requires two separate coin tosses.
5. Note that Hair Color and Eye Color require four (4) coin tosses each.
6. Circle the appropriate phenotype for each characteristic. The "Checklist for Phenotypes" is provided for your convenience.
7. Describe your child in 100 words or less.
8. ** Show what your child will look like. You may do this by:
    a. A drawing in any medium (one sheet only)
    b. Tracing facial parts on a paper
    c. Copying all face parts using those appropriate parts.

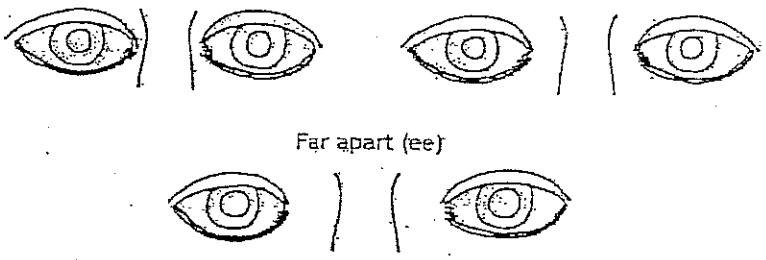
Hair color: Dark hair is dominant over light. To determine the color of the offspring's hair, assume there are two gene pairs involved. There are probably more. Flip your coin first to determine the genotype of the first pair of genes: (AA, Aa, aa). Now flip your coins again to determine the genotype of the second pair of the alleles (BB, Bb, bb). Then match the genotype with the corresponding hair color by looking at the following chart.

If the genotype is:	*Then the hair color is:*
AABB	black
AABb	black
AAbb	red
AaBB	brown
AaBb	regular blonde
Aabb	brown
aaBB	dark blonde
aaBb	regular blonde
aabb	pale yellow blonde

Eyebrows (2)

Color of Eyebrows: Darker than Hair (HH) Same as Hair (Hh) Lighter than Hair (hh)

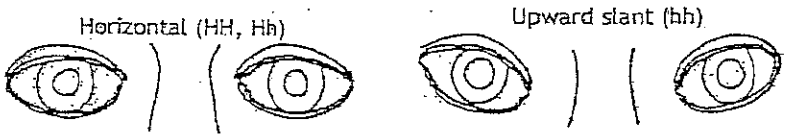
Eyes Distance Apart



Size:

Shape:

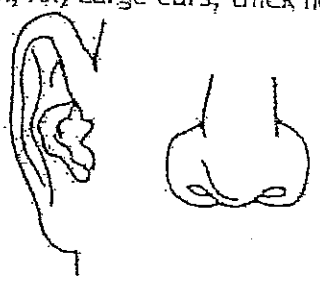
Slantedness (Position):



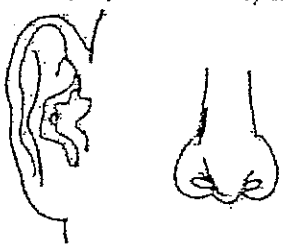
Note: Nose tip thickness and size of ears are almost always inherited together. In other words, thick nose tip and large ears are usually inherited togehter, but not always.

Flip Coins First:

(XX, Xx) Large ears, thick nose



(xx) small ears, narrow nose



To see if the traits have stayed together, flip again. If both tails come up and the results of the first flip called for big ears, make the ears small. If the results called for small ears, make them big.

Ear Lobes:

Free (FF, Ff)

Attached (ff)

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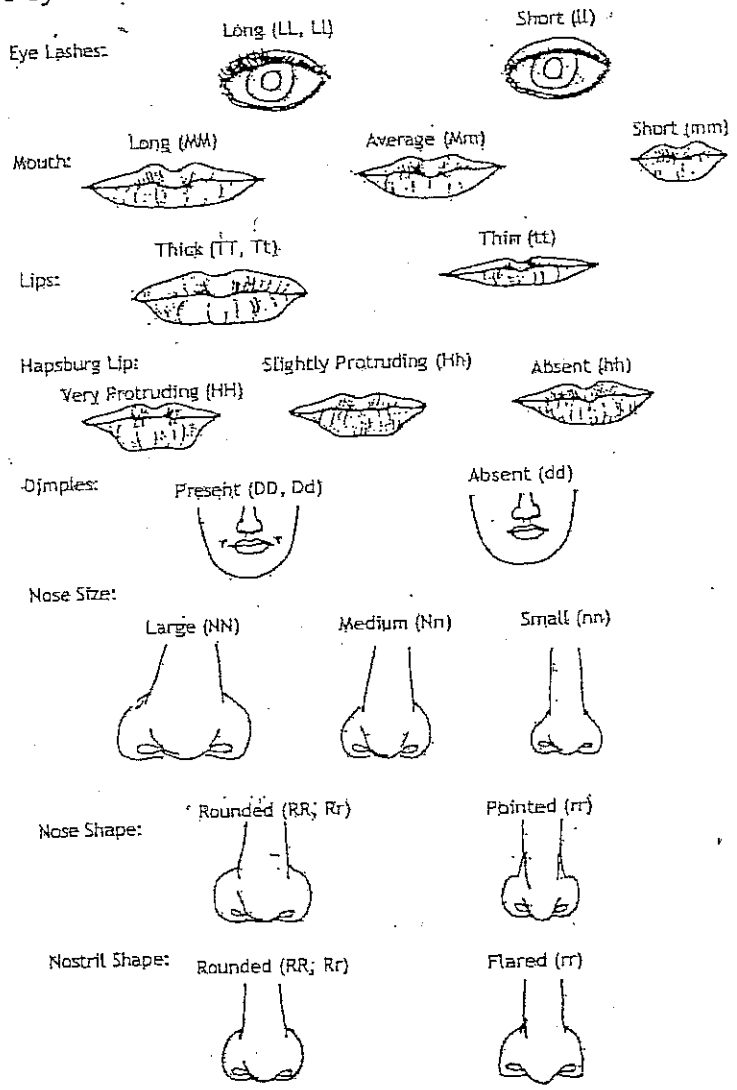
Eye color: Dark eyes are dominant over light. To determine the color of the offspring's eyes, assume there are two gene pairs involved, one which codes for depositing pigment in the front of the iris, and one which codes for depositing pigment in the back of the iris. Determine the genotype of the first pair (AA, Aa, aa). Then flip again to determine the second pair of genes (BB, Bb, bb).

If the genotype is:	
AABB	dark brown
AABb	dark brown
AAbb	brown
AaBB	brown/green fleck
AaBb	brown
Aabb	gray-blue
aaBB	green
aaBb	dark blue
aabb	light blue (haze)

Then the eye color is:



Checklist for Phenotypes—circle your coin flip results

Sex
Male
Female

Face shape
round
square

Chin shape (1)
very prominent
less prominent

Chin shape (2)
round
square

Cleft chin
absent
present

Eye shape
round
almond

Eye position
horizontal
upward slant

Eye color
dark brown
brown
green
brown/green flecks
gray blue
dark blue
light blue

Eyelashes
long
short

Freckles
present
absent

Hair texture
curly
wavy
straight

Widow's peak
present
absent

Hair color
black
brown
red
blonde
dark blonde
pale blonde

Eyebrows (1)
bushy
fine

Mouth
long
average
small

Lips
thick
thin

Hapsburg lip
very protruding
slightly protruding
absent

Dimples
present
absent

Nose
big
medium
small

Eyebrows (2)
not connected
connected

Color of eyebrows
darker than hair
same as hair
lighter than hair

Eye distance
close together
average
far apart

Eye size
large
medium
small

Nose shape
rounded
pointed

Nostril shape
rounded
flared

Ear and Nose size
large ear/wide nose
small ear/narrow nose

Earlobes
free
attached

Darwin's ear point
present
absent

Hairy ears (males only)
present
absent

Darwin's Ear Point

Present (DD, Dd)

Absent (dd)

Hairy Ears: Note: Occurs only in males (Sex linked)

Absent (EE, Ee)

Present (ee)

Feckles:

Present (FF, Ff)

Absent (ff)

DISCUSSION:

1. *Compare the image of your child to the children of the rest of the class. How much variation is there in this group?*
2. *If you plan to have your second child, how will the picture of your first child compare to your second child?*
3. *Why are hair color and eye color different from the other genetic characteristics?*
4. *What is incomplete dominance? Which traits of your child are incomplete dominance?*
5. *Nose tip thickness and size of ears are almost always inherited together. What does this suggest about the gene for nose tip thickness and the gene for ear size?*

Who Ate the Cheese?!

Note: This simulation is slightly modified from the original posting by Shannan Muskopf at biologycorner.com. Credit is fully given to her for its original creation.

Standards Met in the NY State Core Curriculum for Living Environment

Standard 4 Key Idea 2
Performance Indicators 2.1 g and 2.1 h

Appendix A of Lab Skills for Living Environment

Objectives: In this simulation you will examine crime scene evidence to determine who is responsible for eating the Queen's special imported Lindberger Cheese (yes, the stinky cheese). You will model the process of electrophoresis and DNA fingerprinting.

ROYAL GUARD INCIDENT REPORT

Incident Data

Incident Type:	Theft	Complaint Status	Pending DNA results
Processed by:	Chief Wiggam	Other Officers:	Officer Li Gase

Property

Property Code:	Rare cheese	Owner's Name	Queen Elizabeth
Name:	Lindbergher	Value:	$12,000

Burglary Data

Method of Entry: Unknown, no evidence of force on doors or windows.

Narrative: The cheese was allegedly stolen from the Queen's sitting room the night before the grand ball. The cheese was listed as a gift from the Manchurian diplomat. Officer Li Gase dusted for fingerprints and found none on the table or doors, the maid claimed that they had been wiped clean earlier. The wheel of cheese was on a platform in the sitting room, and half of it had been eaten. We took pictures of the half eaten cheese and sent it to the lab for further tests. Edna N. Zime, the lab technician said that saliva samples could be taken from the teeth imprints of the cheese that was left behind.

Suspect Data

Suspect Number: 1
Name: Princess Dubbah Elix
Description of Suspicion: The princess was seen entering the sitting room earlier in the evening. She is well known for her love of cheese.

Suspect Number 2
Name: Electra Foresis
Description of Suspicion: Electra was recently involved in a relationship with the Manchurian diplomat that sources say ended badly. Her motive may have been to sabotage the diplomat's gift to the Queen.

Suspect Number 3
Name: Ada Nine
Description of Suspicion: Ada was the maid in charge of cleaning the sitting room. She had access to the cheese.

Suspect Number 4
Name: Gene Tics
Description of Suspicion: Gene is the leader of the local Cheese-Makers Guild, he may not have wished for Queen Elizabeth to have cheese from anywhere but his own guild.

Crime Lab Data

Crime Lab Investigator	R. Renee	Lab Technician	Edna N. Zime
List of Evidence Received	Plastic bag with cheese crumbs	List of Procedures Used	DNA extraction Polymerase Chain Reaction DNA restriction Analysis

Narrative: After receiving the package with the plastic bag marked Crime Scene, the DNA was extracted. Because the sample was so mall, the DNA was amplified using the polymerase chain reaction. We isolated the DNA from the four suspects and compared them to the crime scene DNA using DNA restriction analysis.

Results: See attached DNA Results

DNA Evidence Evaluation

1. Turn your paper strips (DNA sequences) so that the side with the bases is facing you. The restriction enzyme cuts at ever point it finds C C G G, always cutting between the C and the G. Label the back of the slips with the suspect number so that you don't get them confused after cutting. Use scissors to cut the DNA sequence at the C C G G points.

2. Count the number of base pairs (bp) in each piece of DNA that you created. Record the base pair number on the back side of the DNA fragment.

3. Use the chart for a simulation electrophoresis.

4. Tape your DNA fragments to the chart, using the base pair numbers as a guideline for fragment placement.

5. Compare the crime scene DNA to the suspects and indicate on your chart, which suspect is guilty of eating the cheese.

Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA Crime DNA

GTCGACCGGTGACCGTGCGTACACAGTGCTCCGGATAGCTGATAGCTCCGGTG

CAGCTGGCCACTGGCACGCATGTGTCACGAGGCCTATCGACTATCGAGGCCAC

Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA Suspect 1 DNA

GTCCCAGCCGGACCGTACCGGTAGATCAGCCGGTAGATTGATAGCGTGATGTG

CAGGGTCGGCCTGGCATGGCCATCTAGTCGGCCATCTAACTATCGCACTACAC

Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA Suspect 2 DNA

GTCTACGTAATCGTAGCCATCCGGACAGTGTGCACGATCGTACATGCTACGTG

CAGATGCATTAGCATCGGTAGGCCTGTCACACGTGCTAGCATGTACGATGCAC

Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA Suspect 3 DNA

GTCGACCGGTGACCGTGCGTACACAGTGCTCCGGATAGCTGATAGCTCCGGTG

CAGCTGGCCACTGGCACGCATGTGTCACGAGGCCTATCGACTATCGAGGCCAC

Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA Suspect 4 DNA

GTCTCCATCCGGACTACCATACATCTGGTGTACCCGGTGATATCGTCCGGGTG

CAGAGGTAGGCCTGATGGTATGTAGACCACATGGGCCACTATAGCAGCCCCAC

Simulated Electrophoresis Gel

Negative pole (-)

30					
29					
28					
27					
26					
25					
24					
23					
22					
21					
20					
19					
18					
17					
16					
15					
14					
13					
12					
11					
10					
9					
8					
7					
6					
5					
4					
3					
2					
1					

Positive pole (+)

Genetic Science Learning Center | Name_____ Date_____

Let's Clone a Mouse, Mouse, Mouse . . .

Activity Instructions - Page 1

FIRST, A LITTLE HISTORY:
In 1996, Dolly the sheep became the first mammal to be cloned by transferring the nucleus from an adult somatic cell into an enucleated egg cell. To confirm that Dolly was truly a clone, researchers at the University of Hawaii used a similar process in 1998 and ultimately cloned 50 mice. In this activity you will simulate their steps of somatic cell nuclear transfer to produce an exact clone, or genetic copy, of a mouse.

MATERIALS:
- Lab Benchtop illustration with 4 Petri Dishes
- Mice Cut-outs page
- Crayons, colored pencils or markers
- Scissors
- Tape

INSTRUCTIONS:

1. Color the cells as follows:
   - Cumulus Cell Nucleus and Cumulus Cell, blue
   - Egg Cell Nucleus and Egg Cell, blue
   - Morula (the ball of cells), green

2. Color the three large female mice as follows:
   - Somatic Cell Donor, brown
   - Egg Cell Donor, black
   - Surrogate Mother, white
   - Don't color the Mouse Pup just yet

3. Cut out the mice and the Morula, and spread them out in front of you.

4. From the brown mouse (the Somatic Cell Donor), cut out the Cumulus Cell and place it in Petri Dish 1.

5. From the black mouse (the Egg Cell Donor), cut out the Egg Cell and place it in Petri Dish 2.

6. Cut out and discard the nucleus from the Egg Cell in Petri Dish 2. Do not remove any of the cytoplasm.

Genetic Science Learning Center | Name_____ Date_____

Let's Clone a Mouse, Mouse, Mouse . . .

Activity Instructions - Page 2

INSTRUCTIONS - Continued:

7. Place the enucleated Egg Cell in Petri Dish 3.

8. Cut out the nucleus from the Cumulus Cell in Petri Dish 1, making sure that no cytoplasm is left surrounding the nucleus.

9. Place the Cumulus Cell Nucleus into the enucleated Egg Cell in Petri Dish 3, and tape them together on the back.

10. Tape (on the back) the Egg Cell with the newly replaced nucleus onto Petri Dish 4 and let it rest for about 2 minutes. This waiting time represents the 1 to 6 hours that the new nucleus needs to successfully adjust to the Egg Cell.

11. The new Egg Cell needs to be chemically stimulated in order to divide and grow into an embryo. To represent this chemical activation, color Petri Dish 4, including the new Egg Cell, entirely with yellow (the yellow color over the new Egg Cell should hint at a green color).

12. After it is chemically stimulated, the new Egg Cell divides into a ball of cells called a Morula. Cover the new Egg Cell with the Morula (colored green).

13. After the new Egg Cell divides into a Morula, it is placed into the Womb of the Surrogate Mother mouse (colored white). Tape the Morula into the Womb of the Surrogate Mother.

14. After about 19 days, the Surrogate Mother mouse will give birth to a new Mouse Pup.

15. Which adult mouse will the Mouse Pup resemble? What color will it be? Color the newly delivered Mouse Pup this color.

16. Clean your lab station and answer the Activity Questions.

Genetic Science Learning Center | Name_____ Date_____

Let's Clone a Mouse, Mouse, Mouse . . .

Activity Instructions - Page 1

1. What does the Nucleus contain? What role do its contents play in the cell?

2. What is the purpose of the Somatic Cell Donor?

3. What is a Somatic Cell?

4. What is the purpose of the Egg Cell Donor?

5. What is the major difference between a somatic cell and an egg cell?

6. What is the purpose of the Surrogate Mother?

7. What color did you color the Mouse Pup? Why?

8. What gender (male or female) will the Mouse Pup be? Why?

9. How is this method of cloning different from artificial embryo twinning?

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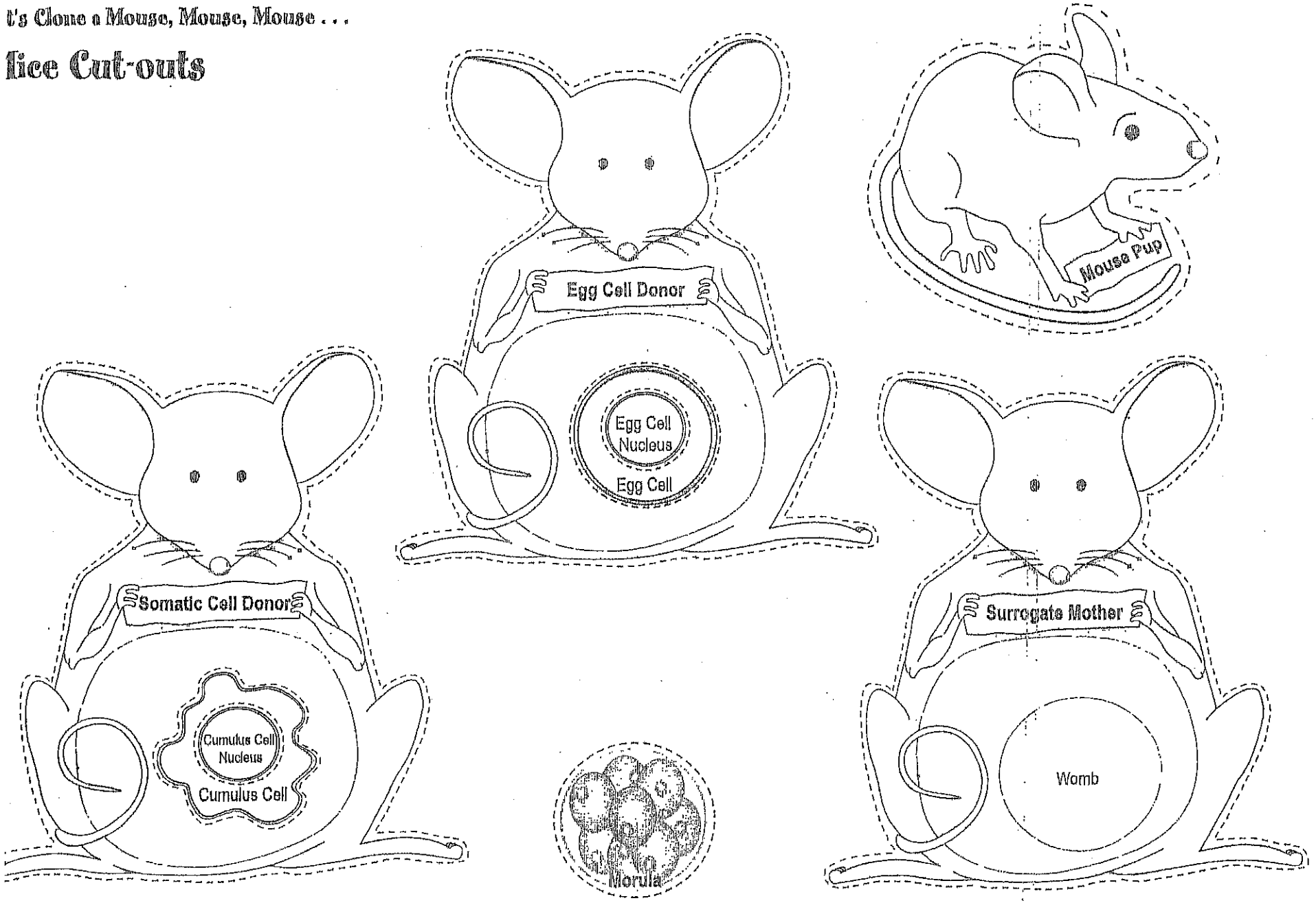
t's Clone a Mouse, Mouse, Mouse . . .

lice Cut-outs



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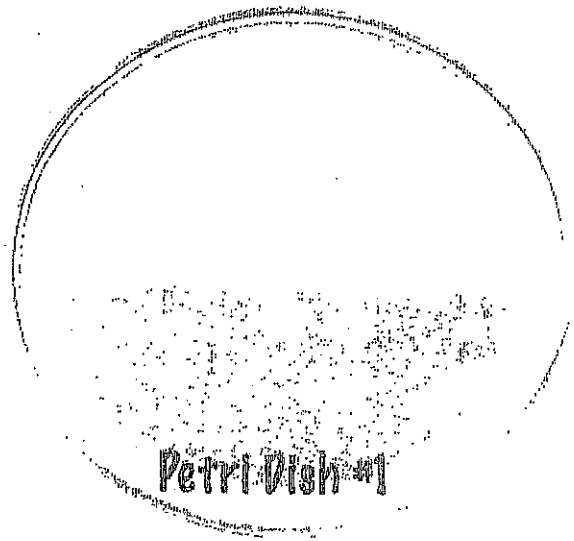
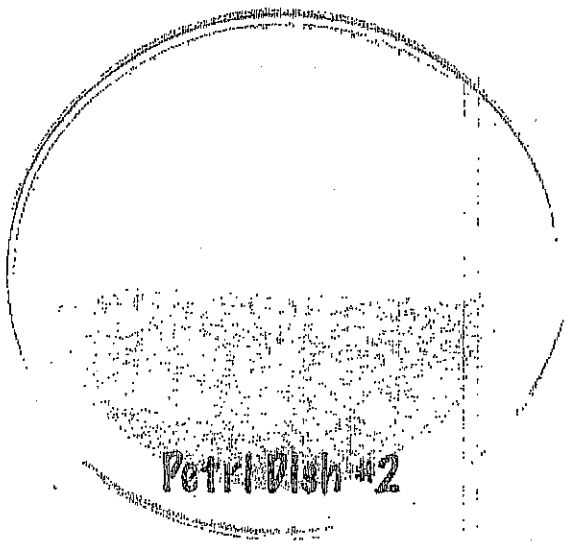
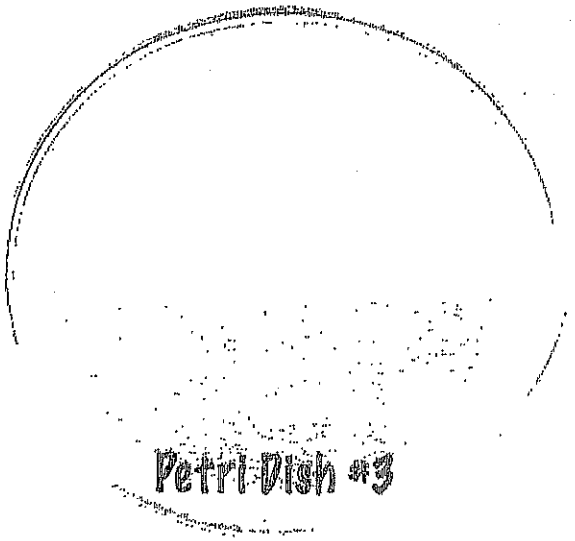
b Benchtop







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NAME _____ DATE _____

PARTNER _____ TEACHER _____

Structure of a Flower

BACKGROUND: The *angiosperms* are seed-bearing plants that produce flowers. The seeds, which contain the plant embryos, are produced in the flower. All the parts of a flower are actually modified leaves that are specialized for their roles in the reproductive process.

Flower structures can be divided into two groups: the essential organs and the accessory organs. The *essential organs* are the reproductive structures, the *stamens* and *pistils*. The *accessory organs* are the *sepals* and *petals*. They surround and protect the essential organs.

As you study a typical flower, note how the flower parts are adapted for the production and protection of seeds.

OBJECTIVES: In this activity you will:

1. Examine the structure of a typical flower.
2. Study the arrangement and structure of the male and female reproductive organs of the flower.
3. Examine under the microscope the parts of the flower from which the seeds develop.

MATERIALS:

tulip, lily, or gladiolus flower	cover slips	pipette
dissecting needle	microscope	0.01% methylene blue stain in dropper bottle
hand lens	transparent tape	paper towel
scalpel	sheet of unlined paper	facial tissue
slides	water	

PROCEDURES AND OBSERVATIONS:

Part 1. The Accessory Organs

Flower parts are arranged in circles or *whorls*. They are attached at the enlarged base of the flower, the *receptacle*. The *sepals* form the outer-most whorl of the flower. They may be green or brightly colored and are thickened at the base. The sepals provide support and protection for the inner flower structures. The whorl of sepals is called the *calyx*. The petals are found directly inside the sepals. The color and odor of the petals help to attract birds and insects to the flower for pollination. The whorl of petals is called the *corolla*.

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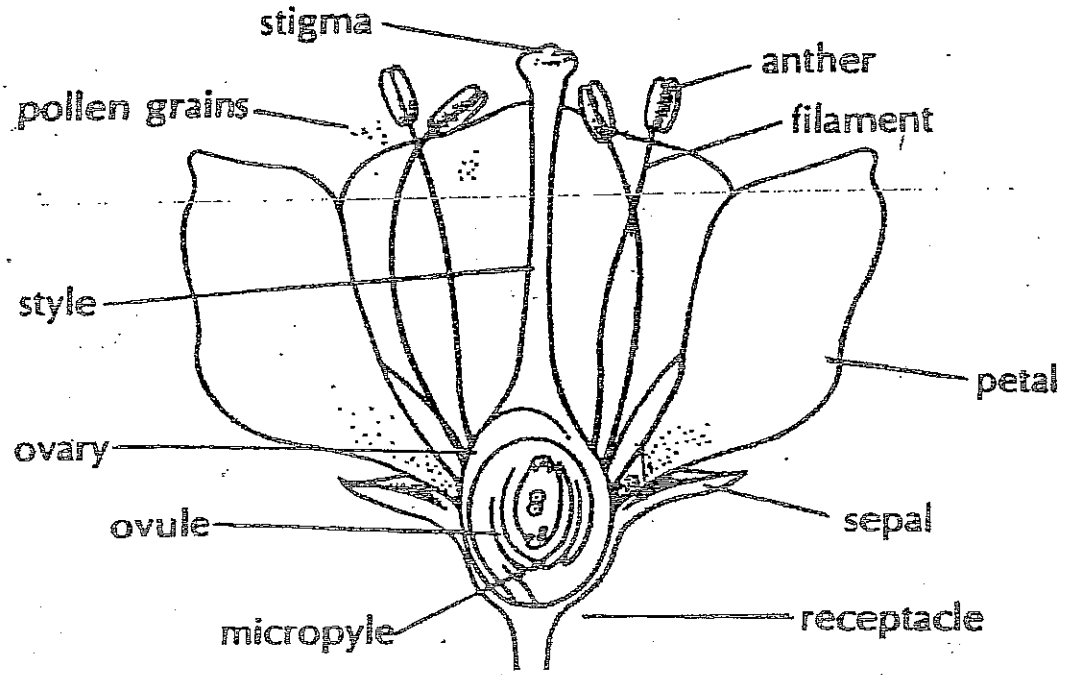
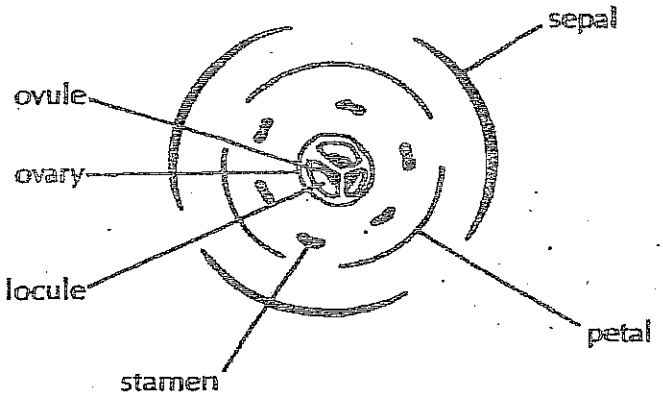
FIGURE 1



1. Look directly into the center of your flower. Handle it gently so as not to damage any of the parts. Notice that all of its parts are arranged around the center whorls. Also note how all parts are attached at the base of the flower. You can see the receptacle best by looking at the underside of the flower.

FIGURE 2



2. Locate the sepals, the outer whorl of the flower. (See Figures 1 and 2.)

How many sepals does your flower have? _____

Describe the appearance of the sepals. _____

_____

_____

3. Carefully remove the sepals. With your thumb and forefinger, gently break off each sepal where it is attached to the receptacle. Notice the leaf-like structure. Hold one up to the light to see the veins that conduct water and nutrients.

4. With transparent tape, attach the sepals in a row to the bottom of a sheet of paper. Label one sepal. Under the row of sepals write a title: CALYX.

5. Observe the next whorl of flower parts, the petals. See Figure 2.

   How many petals does your flower have? _____

   Describe the appearance of the petals. _____

   _____

   _____

6. Carefully remove the petals. If the stalk-like stamens seem to be attached to the petals, carefully free them and save them. Notice the leaf-like structure of the petals. Sniff them.

   Do the petals have an odor? _____

   How do the petals compare with the sepals in size and thickness? _____

   _____

   _____

7. Tape the petals to the sheet of paper in a row above the sepals. Label one petal. Under the row of petals write a title: COROLLA.

Part 2. The Essential Organs

The stalk-like structures inside the petals are the *stamens*, the male reproductive organs. The stamen is made up of two parts. The *anther* is the enlarged top of the stamen. The *filament* is the thin structure that supports the anther.

8. Observe the stamens of your flower. (See Figure 1.) Identify the filaments and the anthers.

   How many stamens does your flower have? _____

9. Gently break off the stamens at their bases. Set one aside on a paper towel. Tape the rest of the stamens to the sheet of paper above the petals, leaving a space in the center of the row. Label one anther and one filament. Then label the row of stamens. Title the row: STAMENS.

Inside the anther are four pollen sacs. Seen from the outside, the pollen sacs look like bulging tubes. Special cells in the pollen sacs undergo meiosis and form pollen grains. The sperm nuclei are produced by the nuclei of the pollen grains. When the pollen grains mature, the pollen sacs split open, releasing the dust-like pollen grains.

10. Examine the anther of the stamen that you set aside. Note that it has two elongated parts. Note the two elongated parts containing the pollen sacs.

Have the pollen sacs opened? _____

How can you tell? _____

_____

11. Prepare a slide of pollen grains. With a pipette, place a drop of water in the center of a clean slide. If the pollen has been released from the pollen sacs, tease some of the grains into the drop of water with a dissecting needle. If the pollen has not been released, carefully cut the anther from the filament with the scalpel. Lay the anther on the slide and split open the bulging pollen sacs with a dissecting needle. Then tease some of the pollen grains into the drop of water. Add a cover slip. Put the anther aside for Step 15.

12. Examine the slide under low power. When you have located the pollen grains, switch to high power.

13. Sketch several pollen grains on your paper above the stamens. Under the drawing write the title: POLLEN GRAINS.

The central structure of the flower is the female reproductive organ, the *pistil*. The top of the pistil is the *stigma*, where pollen grains land during pollination. The *style* is the middle portion of the pistil. It supports the stigma. (The tulip flower lacks a style.) The *ovary* is the enlarged structure at the bottom of the pistil. The female reproductive cells, the eggs, are produced in the ovary.

14. Examine the top surface of the stigma with a hand lens.

Describe the appearance of the stigma. _____

_____

_____

_____

Does the surface feel moist or dry? _____

_____

15. Use a dissecting needle to remove some pollen from the anther you set aside. Transfer the pollen to the stigma. Immediately observe the pollen on the stigma with the hand lens.

What happens to the pollen? _____

_____

_____

16. Observe the style if your flower is not a tulip.

17. With the scalpel, carefully cut the pistil from the receptacle underneath the ovary. Then cut the ovary in half crosswise. Save the lower part. Tape the upper part with the stigma in the space you left in the stamen row. Title it: PISTIL. Carefully label stigma, style, and ovary.

Within the ovary, ovules develop in hollow compartments called *locules*. The ovules are attached to the ovary by a tissue called the *placenta*. The outer coats of the ovule surround the *embryo sac*, which holds the egg.

During pollination, pollen grains are trapped on the stigma. A pollen tube grows down through the style to an ovule and enters it, making a passageway for the sperm nucleus. The sperm nucleus then enters and unites with the egg nucleus. After fertilization, the wall of the ovule thickens to form the seed, and the ovary wall develops into the fruit.

18. Use the hand lens to study the ovary. Be sure to have light on the specimen.

How many locules do you find? _____

How many ovules are in each locule? _____

19. Prepare a slide to examine some ovules. With a pipette, place a drop of water on a clean slide. Using a dissecting needle, remove several ovules and place them in the drop of water. Add 1 drop of 0.01% methylene blue stain. Then add a cover slip.

20. Place the slide on a paper towel. Be careful not to tip it. Tear off ¼ of a facial tissue and fold it twice. Lay the folded tissue on the cover slip, and press on it firmly with your thumb so as to crush the ovules.

21. Examine the slide under low power. Look for stained nuclei within the embryo sacs. If the ovules are not flattened, or there is not enough stain, repeat steps 19 and 20.

22. Sketch an ovule next to the pistil on your paper. Label any structures you recognize.

23. Preserve your specimen sheet by pressing and drying it. Your teacher will give you directions.

ANALYSIS:

1. In many flowers the sepals are green. The calyx and corolla of your flower are brightly colored and showy. How does this characteristic help in pollination?

2. How does the odor of the petals help pollination?

3. Name the male reproductive organ of the flower and list its parts.

4. In what part of the male reproductive organ are the pollen grains produced?

5. Name the female reproductive organ of the flower and list its parts.

6. In what part of the female reproductive organ are the egg cells produced?

7. How does the structure of the stigma surface aid in pollination?

8. Which parts of the flower become the seed? Which parts become the fruit?

9. In a flower, how does the sperm nucleus from a pollen grain get to the egg nucleus in an ovule?

10. Monocots are flowers whose parts occur in threes or multiples of threes. Dicots are flowers whose parts occur in fours or fives or multiples thereof. Is the flower you observed in this lab activity a monocot or a dicot? What observations led to your conclusion?

CONCLUSION:

Angiosperms evolved fairly recently in Earth's history. Yet this type of plant has quickly become the dominant plant type on Earth. Based on what you have learned in this lab, what advantages do angiosperms have that have led to their dominance?

Name _____ Class _____ Period _____

Before doing this lab, have students read sections 19:1 and 19:3 in the text.

19–1 What Do the Inside Parts of Leaves Look Like?

A leaf is one of the organs of a plant. The main function of a leaf is to make food for the rest of the plant. The food is carried to other plant parts. What parts of a leaf make and carry food?

Since leaves are organs, they are made of many different kinds of tissues. In leaves these tissues appear as layers of cells. Each tissue has a specific function and the shape of the cells in the tissue is related to its function. Some cells look like small boxes stacked side by side, while others are long and balloon-shaped. Certain cells are round and loosely packed while others look like small tubes stacked together.

GOALS

In this exercise, you will:

a. build a model of the structure of a leaf.
b. compare the model with the cells of a leaf as seen through the microscope.

KEYWORDS

Define the following keywords:

epidermis _____

palisade layer _____

spongy layer _____

stoma _____

_____

MATERIALS

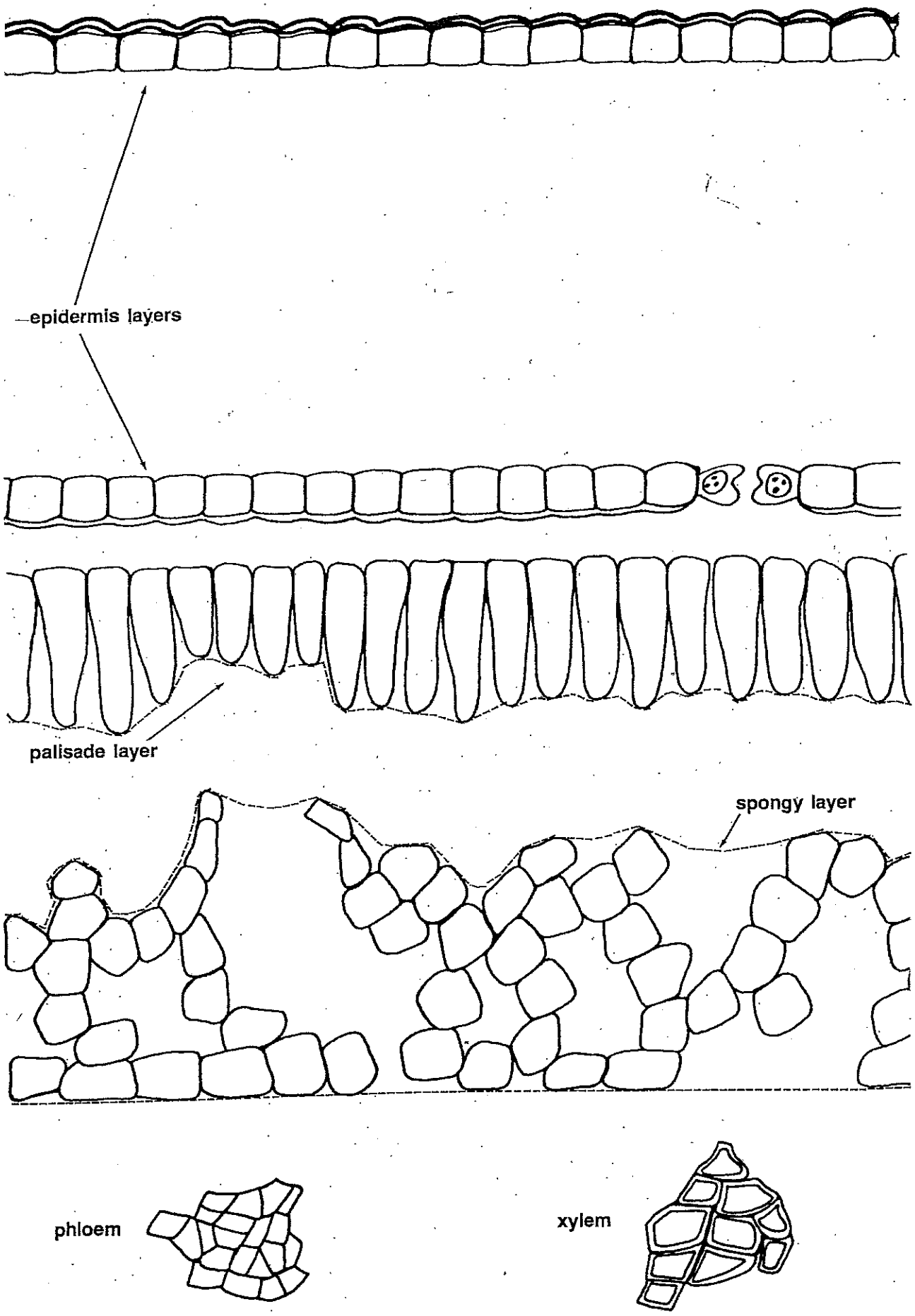
scissors
1 sheet white paper
prepared slide of leaf
colored pencils: red, blue, purple, yellow, tan, light green, dark green
microscope
transparent tape

PROCEDURE

Part A. Making a Model of a Leaf

1. Figure 1 shows the different cell layers of a leaf. Your teacher will provide you with a copy for you to color as follows:
   a. waxy layer—purple
   b. upper epidermis layer—yellow
   c. lower epidermis layer—tan
   d. spongy layer—light green
   e. palisade layer—dark green
   f. xylem—red
   g. phloem—blue
   h. guard cells—dark green

FIGURE 1. Tissue layers of a leaf

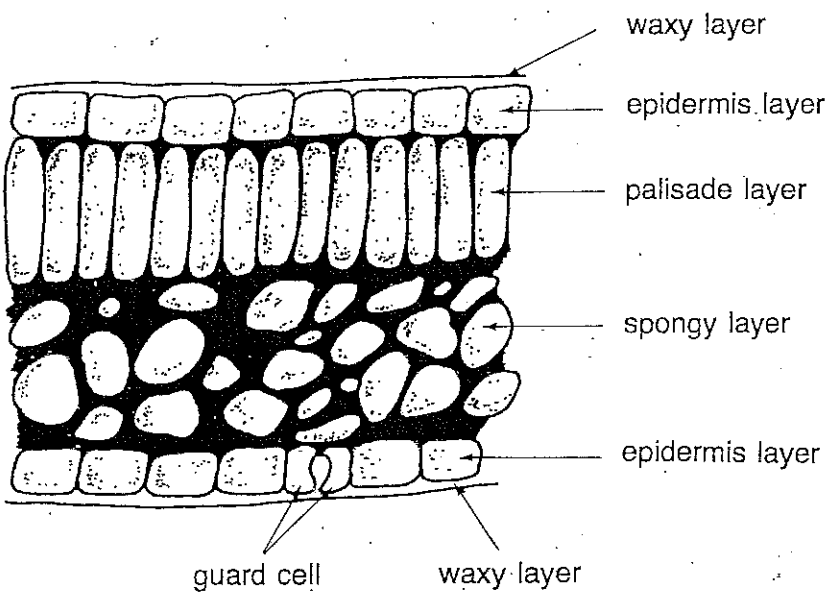


2. Cut out the six layers of your colored copy of Figure 1. Cut along the dotted lines or follow the outlines of the cell layers.
3. Assemble your model of a leaf using Figure 19–6 in your text.
4. Starting with the upper epidermis, tape each layer onto the blank sheet of paper. (HINT: The xylem and phloem fit together like parts of a puzzle.)
5. Label your leaf model by using the key in step 1.

Part B. Examining the Tissues of a Leaf

1. Examine the prepared slide of a leaf cross section on the low power of a microscope.
2. Locate and identify the six cell layers in the leaf section.
3. Draw a small section of the leaf that you see through the microscope on low power in the space provided. Label the parts of this leaf drawing by using the key in step 1.

FIGURE 2. Parts of a leaf



Have students make a diagram of a small section of the leaf rather than trying to draw all they see on the slide.

QUESTIONS

1. List the job of each of the following leaf parts:

   a. waxy layer_____

   b. upper and lower epidermis layers_____

   _____

   c. guard cell_____

   d. spongy layer_____

e. palisade layer_____

f. xylem_____

g. phloem_____

h. stoma_____

2. How many cell layers thick are the upper and lower epidermis?_____

3. Is the waxy layer thicker or thinner than the epidemis?_____

4. How is the waxy layer similar to a plastic bag?_____

5. Describe the differences in the shapes of the kinds of leaf cells that make food._____

6. Where does the phloem get the food that it carries to the stem and roots?

7. Tell which cells in leaves

   a. are box-shaped._____

   b. are shaped like balloons._____

   c. have many air spaces around them._____

   d. are covered with wax._____

8. What would happen to the gases and water in a leaf if the guard cells were closer together, that is, if the stoma were smaller than it is?_____

9. Many houseplants have very thick, waxy leaves. They do not wilt as quickly as houseplants with thinner leaves. Explain why._____

10. The celery stalks that you eat are leaf stalks. What kind of cells are the "strings" inside the celery?_____

Name _____ Period _____ Date _____

Laboratory Activity #1 — Student Laboratory Packet

Relationships and Biodiversity

A Laboratory Activity for the Living Environment

Introduction

Botana curus is a valuable plant because it produces Curol, a compound used for treating certain kinds of cancer. Curol cannot be produced in the laboratory. *Botana curus* grows very slowly and is on the endangered species list, so its ability to provide Curol in large quantities is limited.

Species that are more closely related to *Botana curus* are more likely to produce the important substance Curol. Three similar plant species that are plentiful (X, Y, and Z) may be related to *Botana curus*. You will work as a researcher to:

- gather structural and molecular evidence to determine which plant species is most closely related to the hypothetical species, *Botana curus*
- use this evidence to decide which plant species is most likely to serve as a source of the important substance Curol

Safety

- You will need to wear goggles while conducting Tests 4 and 5.
- Do not eat or drink anything in the laboratory while doing this laboratory activity.

Important Note: Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. Later, you will need to transfer your answers to a separate Student Answer Packet. Your teacher will use the packet in grading your work, and the school will retain it as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.

Structural Evidence for Relationships

Perform the following tests and record your observations in Table 1 on page 8 of this packet. Use a hand lens or microscope as needed.

Test 1—Structural Characteristics of Plants

a. Do not remove the plant samples from the plastic bags/cards.
b. Compare the structural characteristics of the plant samples. Record your observations in Table 1 (see page 8).

Test 2—Structural Characteristics of Seeds

a. Do not remove the seed samples from the plastic bags/cards.
b. Compare the structural characteristics of the seed samples. Record your observations in Table 1.

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Test 3—Microscopic Internal Structure of Stems

a. Use the lowest magnification on your microscope to examine the slides that show cross sections through stems of *Botana curus* and Species X, Y, and Z. Compare the arrangement (circular or scattered) of the bundles of conducting tissue in the specimens. Refer to Figure 1.

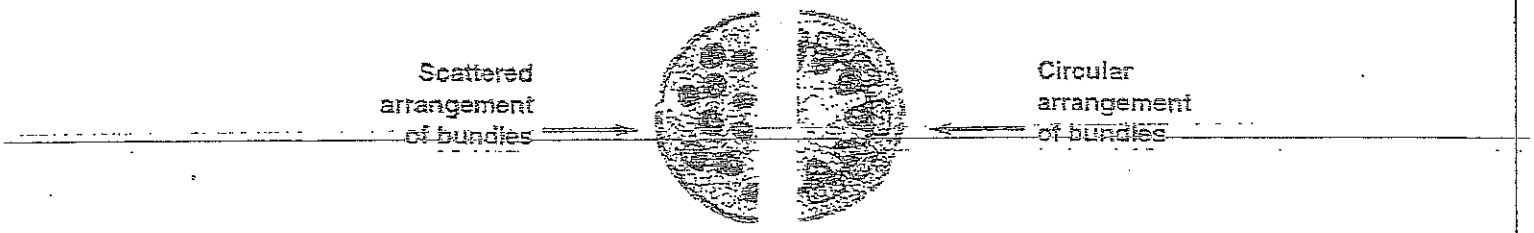

Figure 1

b. Record your observations (using words and/or diagrams) of the conducting tissue arrangements in Table 1.

Hypothesize: Tests 1-3

a. Based on your data for structural relationships, which species (X, Y, or Z) would you hypothesize is most likely to produce Curol? _____

b. Explain how the evidence from your data table supports your hypothesis. You will test your hypothesis by completing additional tests in the second part of this laboratory activity.

_____

_____

_____

Molecular Evidence for Relationships

Test 4—Paper Chromatography to Separate Plant Pigments

a. You must wear safety goggles when performing this part of the activity.

b. Draw a pencil line 2 cm from the bottom of the chromatography paper. Use a pencil to label the top edge of the chromatography paper Bc (*Botana curus*), X, Y, and Z as shown in Figure 1.

c. Use a clean microtip dropper to transfer two drops of plant extract from *Botana curus* just above the pencil line as shown in Figure 1.

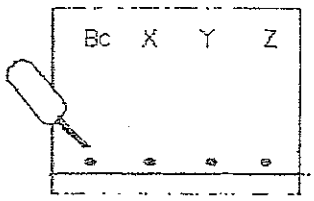

Figure 2

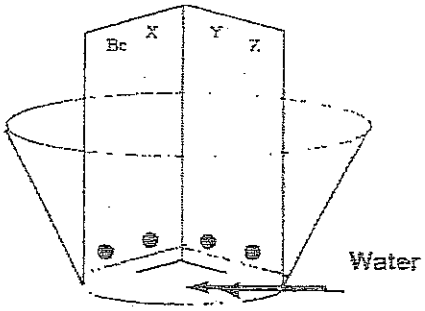

Figure 3

d. *Using a clean dropper each time*, repeat the procedure to place drops of the other plant extracts in the appropriate locations on the paper.

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e. Add just enough water to cover the bottom of the cup approximately 1 cm deep. The water line should NOT be high enough to touch the spots of plant extract on the chromatography paper when the paper is placed in the cup.

f. Fold the chromatography paper and stand it in the cup as shown in Figure 2.

g. The chromatography paper must be removed from the cup before the water line reaches the pencil labels at the top of the chromatography paper. While the plant extracts are moving up the chromatography paper, go on to Test 5, but keep checking on the progress of the water moving up the paper so that you can remove it at the proper time.

h. Once the chromatogram is done, record your observations of the colors and relative amounts of pigments in Table 1.

i. Clean the microtip droppers thoroughly by rinsing them with water. Carefully pour solutions from the chromatography cup into the waste container. Discard the used chromatography paper.

Test 5—Indicator Tests for Enzyme M

a. You must wear safety goggles when performing this part of the activity.

b. It is not practical to test a plant directly for Curol. However, if enzyme M is present, a plant may produce Curol.

c. Test the plant extract from *Botana curus* for the presence of enzyme M. Put one small scoop of indicator powder into one depression of the well tray. Use a clean microtip dropper to add 5 drops of *Botana curus* extract to the indicator powder. A fizzing reaction indicates that enzyme M is present.

d. Repeat the test for enzyme M using the other plant extracts.

e. Record the results of your tests for enzyme M in Table 1.

f. Clean the microtip droppers thoroughly by rinsing them with water. Rinse the well tray and blot it dry using a paper towel.

Reminder: Complete the chromatography tests and observations before going on.

Test 6—Using Simulated Gel Electrophoresis To Compare DNA

a. For this test, you will use the plastic bags containing colored paper strips representing portions of DNA molecules. The letters on these strips represent the sequence of bases in DNA molecules isolated from *Botana curus* and Species X, Y, and Z.

b. To compare DNA molecules, scientists use enzymes that bind to and cut specific base sequences within the DNA. Imagine that you are using an enzyme that binds to the base sequence CCGG and cuts between the C and G. Simulate this cutting process as follows:

b1. Remove one of the colored paper strips from the plastic bag labeled *Botana curus*. Locate and lightly shade all CCGG sequences on the DNA from *Botana curus*. The shaded areas represent where the enzyme would bind to cut the DNA.

b2. Use scissors to cut off all the "white space" above and below the string of letters representing the DNA bases. Also remove the white paper to the left and right of the string of letters. (This will enable them to fit better in the spaces provided in Table 2 on page 9.)

b3. Now cut the strip between the C and G within each of the shaded enzyme recognition sites. This will result in several fragments of DNA.

c. Scientists use *gel electrophoresis* to separate the DNA fragments resulting from this binding and cutting process. In an electrical field, the negatively charged DNA molecules migrate through a gel-like material toward the positively charged pole. The smaller molecules migrate more rapidly through the gel than the larger ones do.

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d. Simulate the electrophoresis process by placing the DNA fragments from *Botana curus* in the appropriate well on the Simulated Electrophoresis Gel (Table 2). Simulate the effect of electrical current on the DNA fragments by counting the number of letters (bases) in each of the fragments and moving them to the appropriate location on the electrophoresis gel. Refer to the number of DNA letters indicated along the left side of the gel to determine the final position for each fragment.

e. Call your teacher over to check your work for *Botana curus* before you continue with the DNA from the other species.

f. Mark a horizontal line to indicate the final position of each fragment of *Botana curus* DNA on the simulated electrophoresis gel (Table 2), then record the size on the fragments (number of bases in each) in Table 1.

g. Repeat this process for each of the other species (X, Y, and Z): lightly shade the CCGG sequences, cut the DNA, and separate the resulting fragments.

h. Mark the final position of the DNA bands for each species on the gel (Table 2), then record the size of the fragments (number of bases in each) in Table 1.

i. Discard the used paper DNA fragments and return all other materials to their original location.

Test 7—Translating the DNA Code To Make a Protein

a. The sequences of DNA bases below represent parts of the genes responsible for the production of one type of protein, an enzyme, produced by *Botana curus* and Species X, Y, and Z.

b. Under each DNA sequence, write the complementary messenger RNA base sequences that each of these gene fragments would produce. *Note:* Unlike during DNA replication, in the production of messenger RNA, the DNA base "A" specifies the RNA base "U."

c. Use the universal genetic code table your teacher provides to translate the messenger RNA base sequences into sequences of amino acids in the protein produced by each species. Write the sequences of amino acids under the messenger RNA sequences.

Botana curus CAC GTG GAC TGA GGA CTC CTC

Sequence of bases in mRNA produced _____

Sequence of amino acids in the protein _____

Species X CAC GTG GAC AGA GGA CAC CTC

Sequence of bases in mRNA produced _____

Sequence of amino acids in the protein _____

Species Y CAC GTG GAC AGA GGA CAC CTC

Sequence of bases in mRNA produced _____

Sequence of amino acids in the protein _____

Species Z CAC GTA GAC TGA GGA CTT CTC

Sequence of bases in mRNA produced _____

Sequence of amino acids in the protein _____

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- State how the amino acid sequence you obtained from the gene fragment for *Botana curus* compares with the sequences for the other three species.

- Summarize your observations of the number of differences in Table 1.

Analysis of Results

1. Using the information in Table 1, identify which plant is most closely related to *Botana curus* and therefore most likely to produce Curol. Explain your choice by citing specific evidence from your research.

2. Did the addition of molecular evidence support or refute the hypothesis that you made earlier based on structural evidence only? Explain why or why not.

3. Which kind of evidence—structural or molecular—is most helpful in making decisions about relationships between species? Explain why.

4. Based on your observations, list three characteristics (structural or molecular) that all four species have in common.

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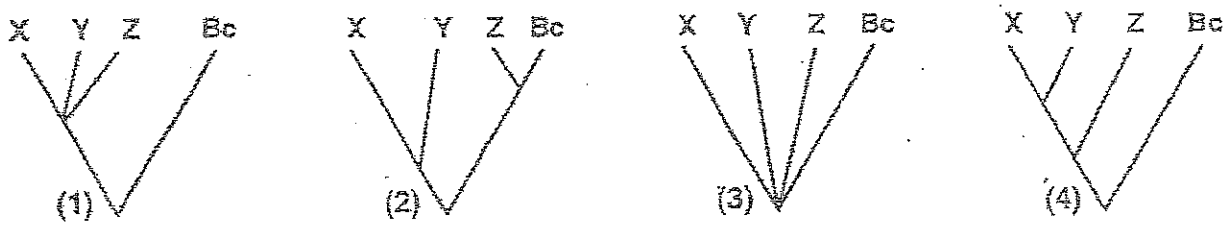
5. Provide a biological explanation for the common characteristics that these species share.

6. Scientists frequently use branching tree diagrams to represent graphically the relationships between species. Which branching tree, shown below, best represents the relationships among the four species? _____



Explain how you used the information on the data table to select this tree.

7. State two additional kinds of evidence you might use to further support your hypothesis about the relationship between *Botana curus* and species X, Y, and Z.

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Base your answers to questions 8 through 10 on the reading passage below and on your understanding of biology.

The Biodiversity Crisis

Plant and animal species are being lost at a rate that is unprecedented in the history of life. Human activities are responsible for much of this biodiversity crisis. Some biologists estimate that within the next century, half of Earth's current species may become extinct.

Extinction and the loss of biodiversity occurs when species do not have adaptations that enable them to survive environmental changes. Human activities such as destruction of natural habitats and pollution are thought to be the major environmental factors causing the decline of species, but others are also important. Overhunting, introduction of foreign species that compete with native species, and removal of predators have also played a significant role in endangering some species.

Why should we worry about the loss of biodiversity? We depend on many species for food, clothing, shelter, oxygen, soil fertility—the list goes on and on. Large-scale extinctions of other species may be a warning to us that we are altering the biosphere so rapidly that our species is threatened too.

Biodiversity ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries having significant value to humankind. Some species have been used as sources for medicines and other useful products. Scientists now use genetic engineering to transfer desirable genes from one species to another. As diversity is lost, potential sources of these genetic materials may be lost with it.

Biodiversity also increases the stability of the ecosystem. Every population is linked, directly or indirectly, with many others in an ecosystem. Disruptions in the numbers and types of one species can upset ecosystem stability. This means that extinction of one species can accelerate the rate of extinction for other species.

Endangered species hold medicinal, agricultural, ecological, commercial, and aesthetic value. They must be protected so that future generations can experience their presence and value.

Assume that the plant you identified as being closely related to *Botana curus* grows rapidly, survives in many environments, and produces Curol. News reports indicate that *Botana curus* plants may become extinct unless expensive efforts are made to preserve the species. Members of your research team disagree as to whether or not *Botana curus* should be saved.

8. State three examples of human activities that could endanger *Botana curus*.

9. State three reasons why it might be important to preserve *Botana curus*.

10. State two arguments people might make for NOT preserving *Botana curus*.

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Table 1: Comparison of *Botana curus* with Species X, Y, and Z

Species	Structural Evidence			Molecular Evidence			
	Structural Characteristics of Plants	Structural Characteristics of Seeds	Microscopic Stem Structure	Paper Chromatography	Test for Enzyme M	Differences in Amino Acid Sequences	Gel Electrophoresis DNA Banding Pattern
Botana curus							
Species X							
Species Y							
Species Z							

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Table 2: Simulated Electrophoresis Gel

- Negative Pole -

Wells →	*Botanacurus*	Species X	Species Y	Species Z
# of DNA bases				
24				
23				
22				
21				
20				
19				
18				
17				
16				
15				
14				
13				
12				
11				
10				
9				
8				
7				
6				
5				
4				
3				
2				
1				

+ Positive Pole +

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Name _____ Date _____

Classification

31

You are constantly using systems of classification in everyday life. For example, you are classified by year in school, age, and color of hair. A phone book or a coin collection are other examples of information or items that are classified for ease in handling.

Taxonomy is that area of life science dealing with classification of living organisms. The value of a classification system to science is threefold. First, it shows relationships among organisms by grouping together living things that have similar characteristics. Second, the last two divisions of the classification system give the scientific name for each organism. Third, the two word name of an organism in the classification system is the same worldwide.

Group names have been established to simplify the complex process of classifying living things. For example, the largest group is referred to as a kingdom. Each kingdom is divided into several smaller groups called phyla (singular, phylum). After successive divisions into smaller and smaller groups, the genus and species are reached. Each living thing is named by its genus and species.

In this investigation, you will
(a) prepare a classification of some common objects.
(b) place these objects into kingdoms, phyla, and classes.
(c) give names to each kingdom, phylum, and class.

Materials

thumbtack	test tube	match	chalk
glass slide	paper clip	penny	file card
seed	pin	wool strand	
rubber band	pencil	plastic tie	

Procedure

Part A. Forming Kingdoms

• Place the objects given to you into two groups. You decide what trait to use as a basis for separating the two groups. Call them Group 1 and Group 2. Equal numbers of objects do not have to be in each group.

1. List the objects that you placed into Group 1.

_____

_____

_____

2. List the objects that you placed into Group 2.

_____

_____

_____

3. What trait was used as a basis for placing objects

(a) into Group 1? _____

(b) into Group 2? _____

4. (a) Using the characteristic or trait in question 3a, design an appropriate but brief name for Group 1. The name should describe the trait you used. (For example, large size group or metal group.) _____

(b) Using the characteristic or trait in question 3b, design an appropriate but brief name for Group 2. The name should describe the trait you used. _____

• If these had been living objects, they would have been placed into groups called kingdoms.

Many biologists group living things into five kingdoms—plants, animals, protists, monerans, and fungi.

Part B. Forming Phyla

• Return to the objects that belong only in Group 1. Regroup these objects into two new groups. Equal numbers of objects do not have to be in each group. Refer to these as Group 1A and Group 1B.

5. List the objects placed into Group 1A. _____

_____

_____

6. List the objects placed into Group 1B. _____

_____

_____

7. (a) What trait was used as the basis for grouping these objects into Group 1A? _____

_____

_____

(b) Based on the trait used, design an appropriate but brief name for Group 1A. _____

_____

8. (a) What trait was used as the basis for grouping these objects into Group 1B? _____

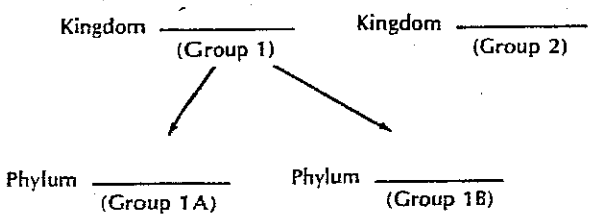
_____

(b) Based on the trait used, design an appropriate but brief name for Group 1B. _____

_____

• If these objects were living, they would have been placed into groups called phyla. Therefore, your answers to questions 7b and 8b are phylum names. There can be many phyla in each kingdom.

FIGURE 31-1



9. Complete Figure 31-1 of your classification scheme so far. Place in the spaces provided the brief name you used in questions 4a, 4b, 7b, and 8b.

10. Are all objects in both phyla also grouped into the same kingdom? _____

• Take the objects of Group 2 and regroup them into three phyla. You decide what to use as a basis for separating the three groups. Equal numbers of objects do not have to be in each group. Refer to these groups as Groups 2A, 2B, and 2C. These groups also would be phyla.

• Decide on brief names which could be used to describe the groupings you made.

11. Complete Figure 31-2 of your classification with the names you have chosen.

Part C. Forming Classes

• Objects in each phylum can be separated further into groups called classes. Each phylum may have several classes.

• Take only the objects in Phylum 2A and separate them into two classes. Refer to them as Groups 2AI and 2AII.

12. (a) Design an appropriate but brief name for Group 2AI. _____

_____

(b) Design an appropriate but brief name for Group 2AII. _____

_____

13. (a) Fill in the following information for any object in Class 2AI. Use the names you have chosen.

Kingdom _____

Phylum _____

Class _____

(b) Fill in the following information for any object in Class 2AII. Use the names you have chosen.

Kingdom _____

Phylum _____

Class _____

Name _____ Date _____

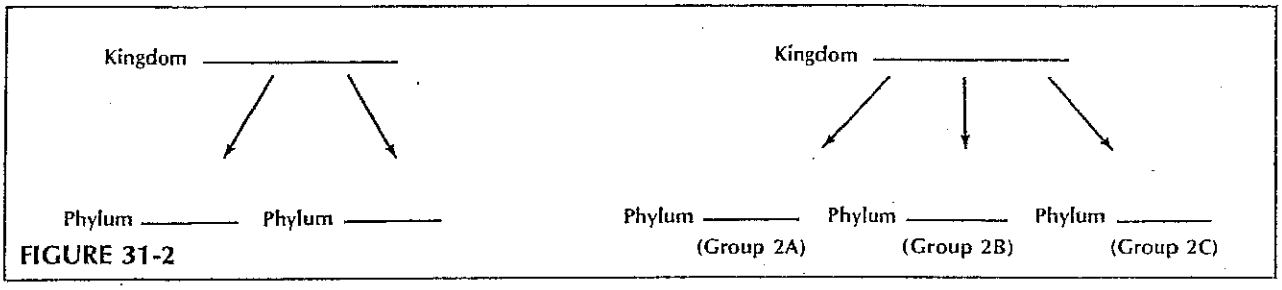


FIGURE 31-2

14. (a) Must all objects in the same class also belong to the same phylum? _____

(b) Must all objects in the same phylum also belong to the same kingdom? _____

• If you were to continue classifying the objects, new group names would appear. For example, classes are broken down into orders, orders into families, families into genera, and genera into species. Thus, the classification of living things is: kingdom, phylum, class, order, family, genus, and species.

Analysis

1. List three reasons scientists classify living organisms. (HINT: Read the introduction.)

_____

_____

2. List the first three group names used in classifications from largest to smallest groups. _____

_____

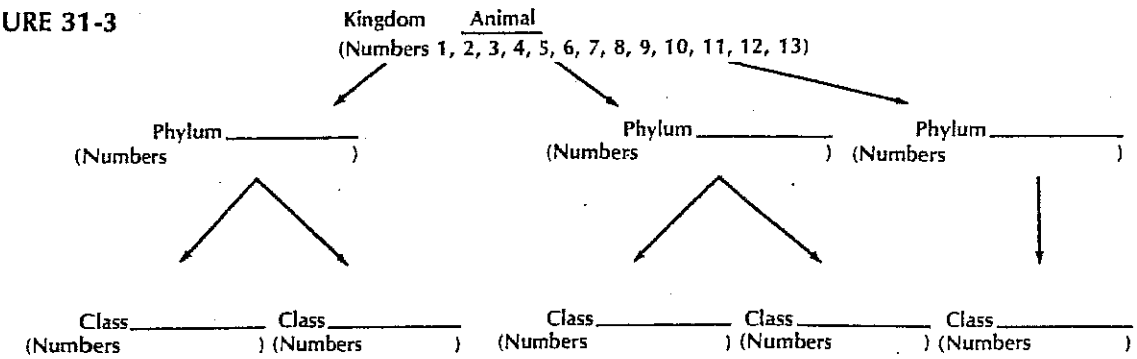
3. (a) In Part A, what trait did you use to form Group 1 (Kingdom 1)? _____

(b) In Part A, what trait did you use to form Group 2 (Kingdom 2)? _____

(c) If given a test tube cork and a nail, into which of your kingdoms would each of these two objects be placed? _____

4. All of the organisms on page 124 belong to the animal kingdom. Design a classification grouping the animals into the outline provided.
   (a) Using the numbers only of each animal, list those animals belonging to each phylum and class in the space marked Numbers.
   (b) Choose a suitable name for each phylum that helps to show the trait you used for your grouping. Write the name on the blank provided.

FIGURE 31-3



07

(c) Choose a suitable name for each class that helps to show the trait you used for your grouping. Write that name on the blank provided.

5. According to the classification scheme in question 4,

(a) must each phylum contain equal numbers of organisms? _____

(b) must each phylum be separated into the same number of classes? _____

6. A student grouped the animals on page 124 into the following two phyla:
Phylum I—numbers 1, 4, 5, 10, 12
Phylum II—numbers 2, 3, 6, 7, 8, 9, 11, 13

What may have been the basis for grouping the animals in this way? _____

_____

7. A different student grouped the animals in Figure 31-4 into the following two phyla:
Phylum I—numbers 1, 3, 4, 5, 6, 7, 8, 9, 10, 12
Phylum II—numbers 2, 11, 13

What may have been the basis for grouping the animals in this way? _____

_____

8. (a) Must all animals belonging to the same class also belong to the same phylum? _____

(b) Explain. _____

9. (a) Must all animals belonging to the same phylum also belong to the same class? _____

(b) Explain. _____

10. (a) In the animal kingdom, one phylum is the chordates. Humans, birds, snakes, and frogs belong to this phylum. What may be the trait being described in this phylum name? _____

_____

(b) The class Amphibia contains frogs and salamanders. What may be the trait being described in this class name? _____

11. Do the traits being used to separate organisms into classes appear to be more general or more specific than those used in separating organisms into kingdoms? _____

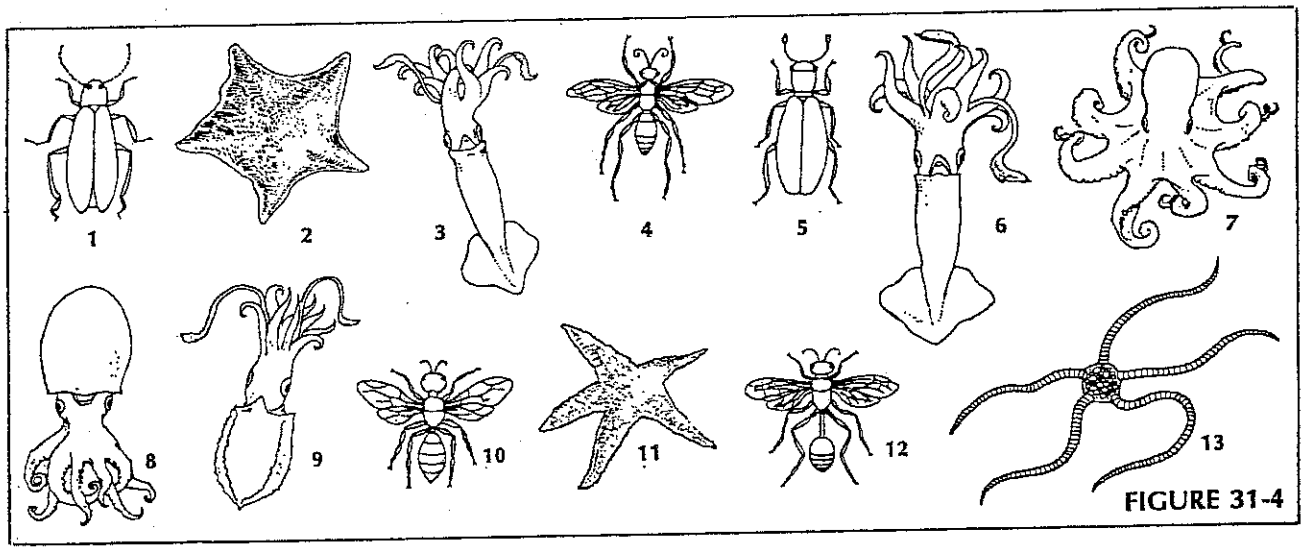


FIGURE 31-4

Name Date

Using And Making A Biological Key

32

Classification is a way of separating a large group of closely related organisms into smaller subgroups. With a classification system, identification of an organism is easy. The scientific names of organisms are based on the classification systems of living organisms. To classify an organism, scientists often use a key. A key is a listing of specific characteristics, such as structure and behavior, in such a way that an organism can be identified.

In this investigation, you will

(a) use a key to identify fourteen shark families.
(b) study the method used in making statements of a key.
(c) construct your own key which will identify organisms appearing on page 128.

Materials

metric ruler

Procedure

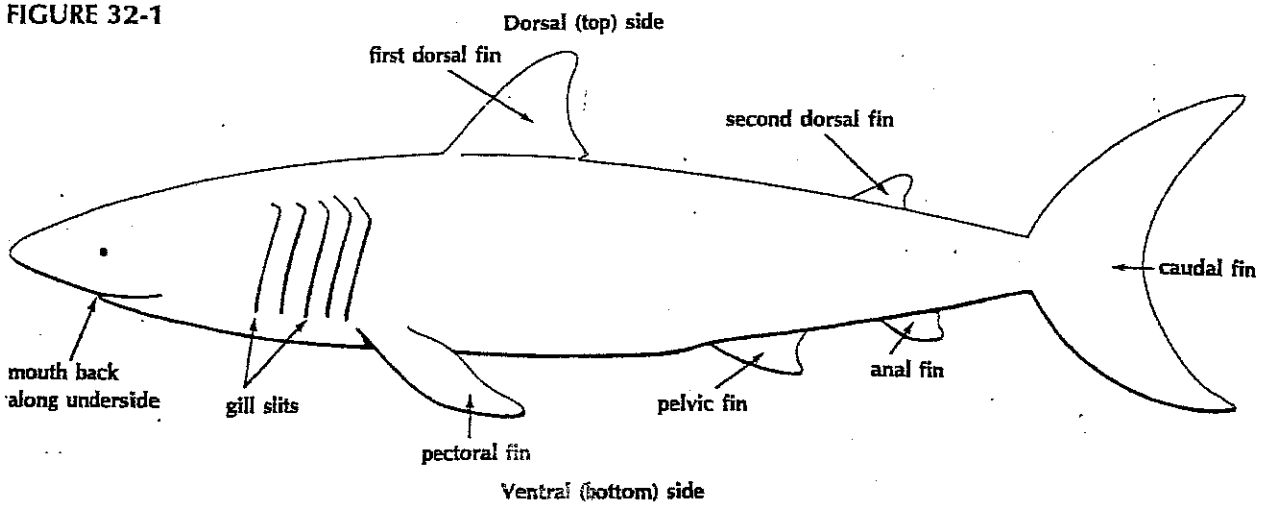
- Use Figure 32-1 as a guide to the shark parts used in the key on page 127.

- Read sentences 1A and 1B of the key. Then study Shark 1 in Figure 32-2 for the characteristics referred to in 1A and 1B. Follow the directions in these sentences and continue until a family name for Shark 1 is determined.

For example, to key a shark that has an anal fin and a body that is not kite shaped, follow the directions of 1A and go directly to statement 2. To key a shark that lacks an anal fin and has a kite shaped body, follow the directions of 1B and go to statement 10.

- Continue this process with each shark until all animals have been identified. Write the family name on the line below each animal.

FIGURE 32-1



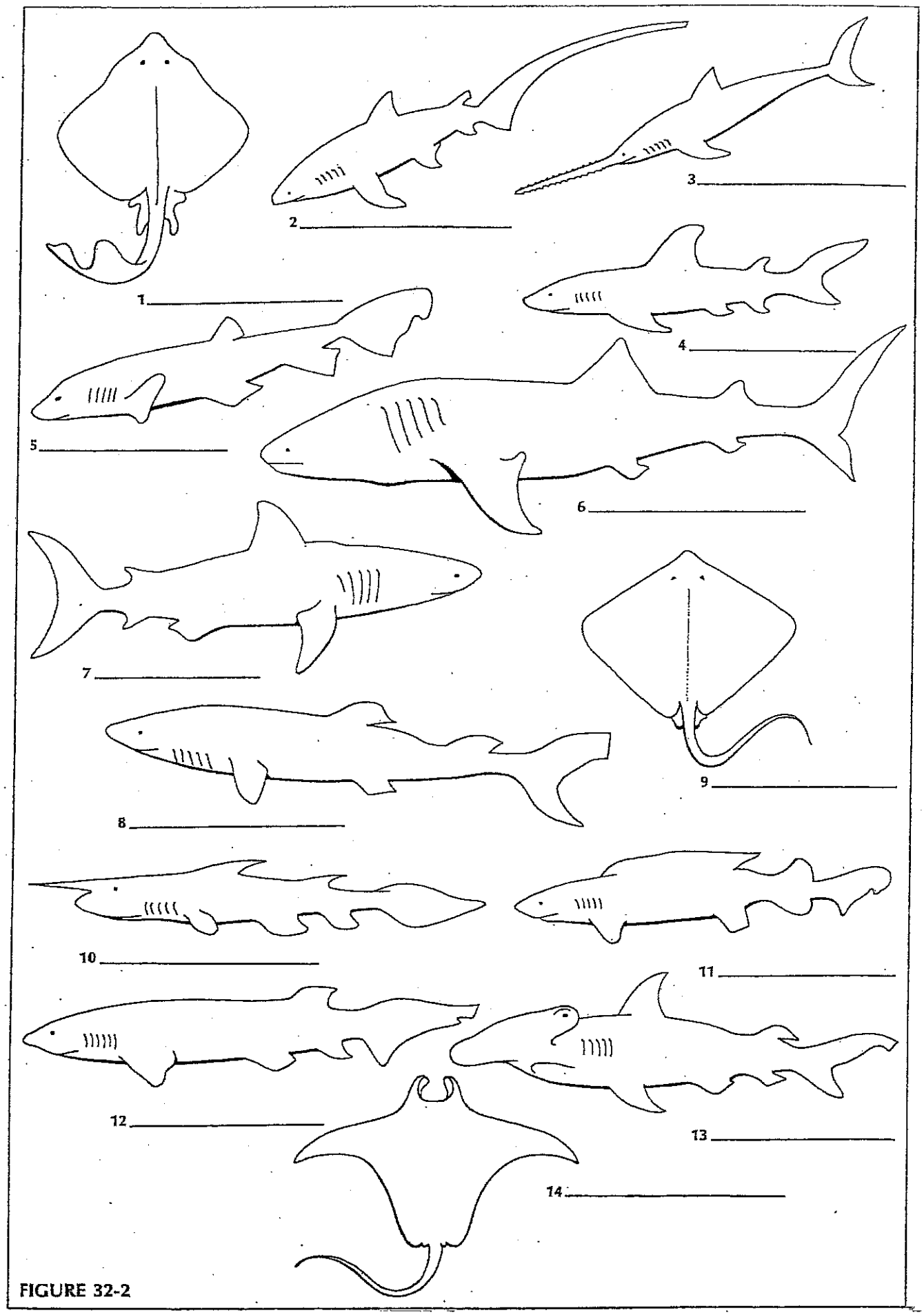


FIGURE 32-2

Name _____ Date _____

Key

1. A. Body kitelike in shape (if viewed from the top) ..... Go to statement 12
   B. Body not kitelike in shape (if viewed from the top) ..... Go to statement 2

2. A. Pelvic fin absent and nose sawlike ..... Family Pristiophoridae
   B. Pelvic fin present ..... Go to statement 3

3. A. Six gill slits present ..... Family Hexanchidae
   B. Five gill slits present ..... Go to statement 4

4. A. Only one dorsal fin ..... Family Scyliorhinidae
   B. Two dorsal fins ..... Go to statement 5

5. A. Mouth at front of head rather than back along underside of head ..... Family Rhinocodontidae
   B. Mouth back along underside of head ..... Go to statement 6

6. A. Head expanded on side with eyes at end of expansion ..... Family Sphyrnidae
   B. Head not expanded ..... Go to statement 7

7. A. Top half of caudal fin exactly same size and shape as bottom half ..... Family Isuridae
   B. Top half of caudal fin different in size and shape than bottom half ..... Go to statement 8

8. A. First dorsal fin very long, almost half total length of body ..... Family Pseudotriakidae
   B. First dorsal fin regular length ..... Go to statement 9

9. A. Caudal fin very long, almost as long as entire body ..... Family Alopiidae
   B. Caudal fin regular length ..... Go to statement 10

10. A. A long needlelike point on end of nose ..... Family Scapanorhynchidae
    B. Nose without long point ..... Go to statement 11

11. A. Anal fin absent ..... Family Squalidae
    B. Anal fin present ..... Family Carcharhinidae

12. A. Small dorsal fin present near tip of tail ..... Family Rajidae
    B. No dorsal fin present near tip of tail ..... Go to statement 13

13. A. Front of animal with two hornlike appendages ..... Family Mobulidae
    B. No hornlike appendages ..... Family Dasyatidae

Analysis

1. What is a biological key and how is it used? _____

_____

_____

2. List four different characteristics or traits that were used in the shark key. _____

_____

_____

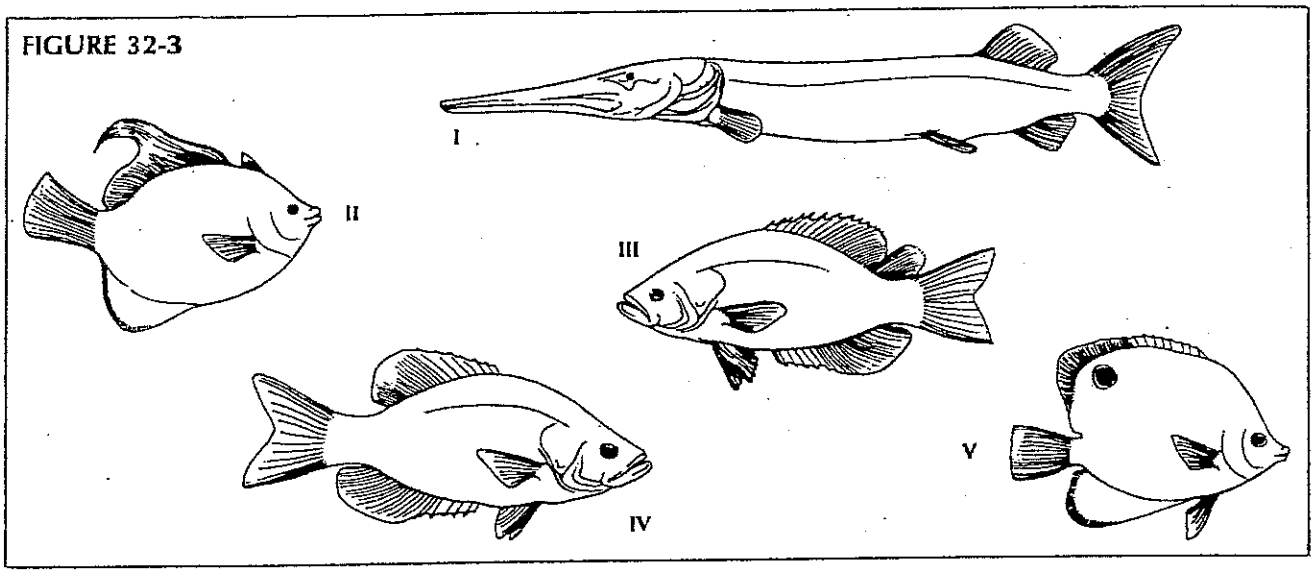
3. (a) What main trait could be used to separate shark 4 from shark 8? _____

   (b) What main trait could be used to separate shark 4 from shark 7? _____

   (c) What main trait could be used to separate shark 5 from shark 12? _____

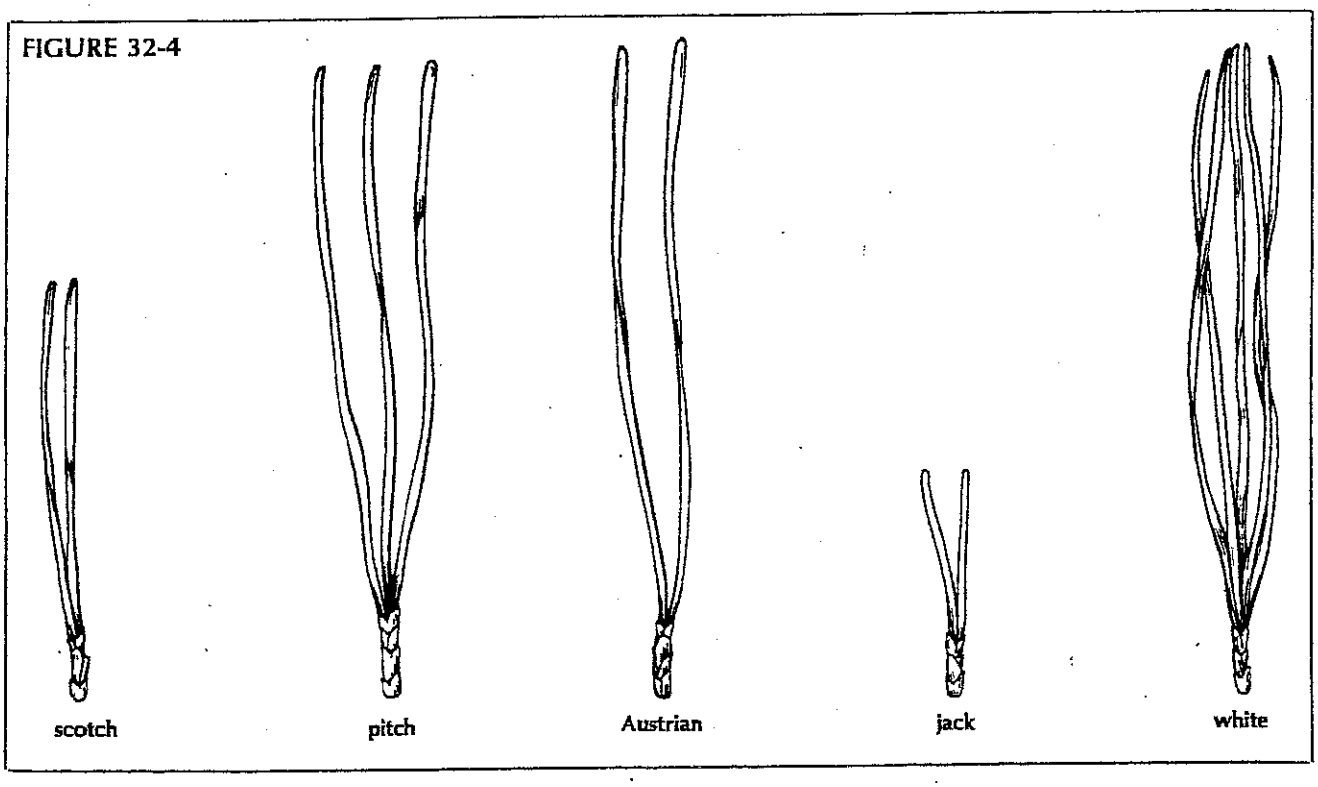
4. Prepare your own key for the five fish in Figure 32-3. Use the same format as on page 127. The family names to be used are the numbers I, II, III, IV, and V. Your key should correctly use traits that will lead to each fish family. To help you get started, we have given you a suggestion for part of the first statements.
   1. A. Fish with long tubelike body
      B. Fish with regular body shape

FIGURE 32-3



5. These leaves (needles) in Figure 32-4 are all from different pine trees and are drawn life size. Note that each bundle contains different numbers and lengths of leaves. Design a key which will classify each tree.

FIGURE 32-4



Name _____	Date _____
Partner _____	Teacher _____

Evidence of Evolution

Background:

Much evidence has been found to indicate that living things have evolved or changed gradually during their natural history. The study of fossils as well as work in embryology, biochemistry, and comparative anatomy provides evidence for evolution.

Objectives:

- Learn about homologous, analogous and vestigial structures and their structures and their significance in evolution theory.

Materials:

Colored pencils

Procedure:

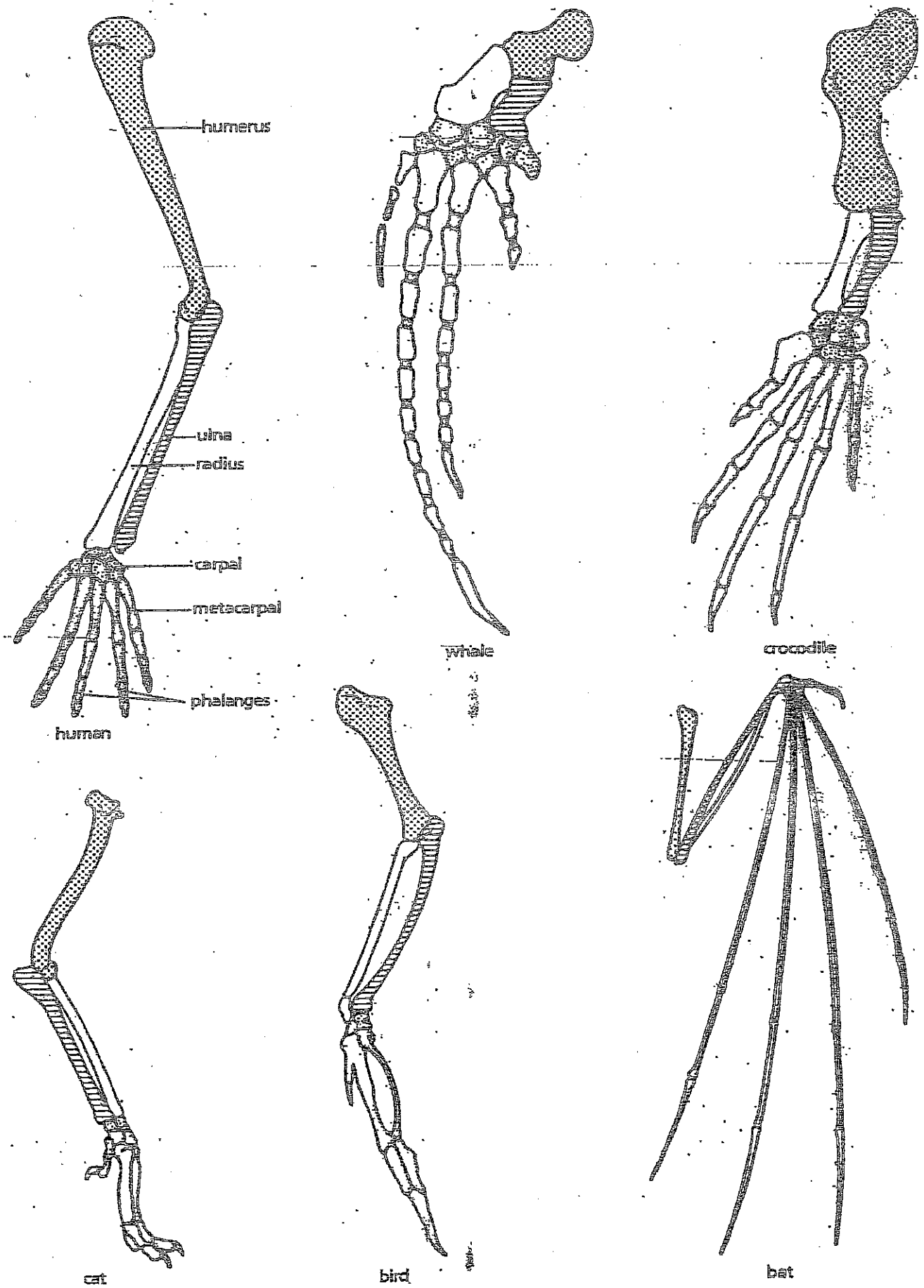
PART 1 : HOMOLOGOUS STRUCTURES

1. Carefully examine the drawings of the bones shown in Figure 1 on the next page. Look for similarities among the various animals.
   a. Color each part of the human arm a different color. (All bones of the wrist should be the same color, the bone groups of the hand should be a different single color.) Then color the corresponding one in each of the other animals the same color as the human bone.
   b. Describe the function of each set of bones below:

Animal	Function
Human	
Whale	
Cat	
Bat	
Bird	
crocodile	

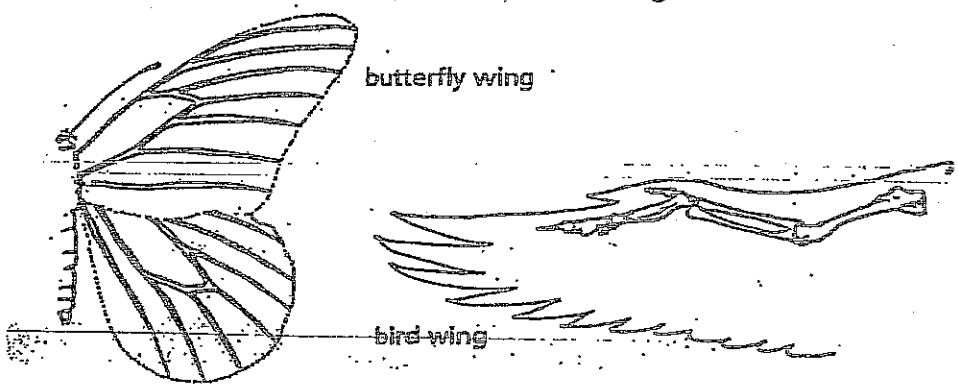
   c. Are these bones arranged in a similar way in each animal?

_____


humerus
ulna
radius
carpal
metacarpal
phalanges
human
whale
crocodile
cat
bird
bat

PART 2 : ANALOGOUS STRUCTURES

1. Examine the butterfly wing and the bird wing shown below:



a. What function do these structures share?

b. How do the structures differ?

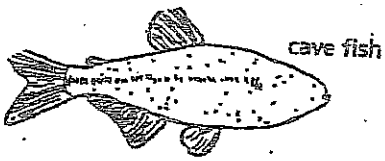
c. Do birds and insects share the structural similarities that would suggest they are closely related taxonomically?

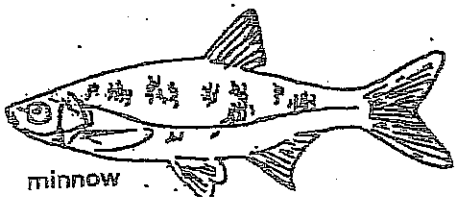
PART 3 : VESTIGIAL STRUCTURES

Gradual changes have occurred through time that have in some cases reduced or removed the function of some body structures and organs. The penguin's wings and the leg bones of snakes are examples of this phenomenon.

1. The cave fish and minnow shown below are related, but the cave fish is blind.

a. Explain why eyesight is not an important adaptation to life in a cave.





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b. Does the appearance of the cave fish and minnow suggest common ancestry? Why?

_____

_____

Organs or structures that have lost their function in the organism and become reduced in size (because of efficiency) are called vestigial structures. Human vestigial organs are well documented.

2. Read the list of human vestigial structures below:
   a. Suggest a possible function for each structure and explain why it became vestigial. Record your answers in the table below:

Structure	Possible Function	Why Vestigial?
Appendix		
Coccyx (tail bone)		
Muscles that move ears		
Muscles that make hair stand up		
Little toe		
Wisdom teeth		

Analysis:

1. Explain why the homologous structures in Part 1 are evidence of evolutionary relationships.

_____

_____

2. Explain the evolutionary relationship between the fin of a fish and the flipper of a whale.

_____

_____

3. List two structures (not mentioned in the lab) that you think are vestigial and explain why.

_____

_____

_____

Name Date

Biochemical Evidence For Evolution

26

If two organisms have similar DNA molecules, they have similar proteins. Similar proteins have similar amino acid sequences (orders). Thus, if amino acid sequences are similar, DNA of the organisms is similar.

Scientists believe that similar DNA sequences indicate a common origin. The more similar the DNA of two living organisms, the more closely related they may be to one another.

Hemoglobin, a protein in red blood cells, has been studied. Scientists know the specific amino acids and their arrangements in hemoglobin molecules of humans, gorillas, and horses.

In this investigation, you will
(a) count and record differences in the sequence of amino acids in similar portions of human, gorilla, and horse hemoglobin.
(b) count and record the molecules of each amino acid present in similar portions of human, gorilla, and horse hemoglobin.
(c) use these data to show how biochemical evidence can be used to support evolution.

Procedure

Part A. Amino Acid Sequence

Figure 26-1 on page 102 represents the amino acid sequence of corresponding portions of the hemoglobin molecules of horses, gorillas, and humans.

- Read the amino acid sequences from left to right beginning at the upper left-hand corner of Figure 26-2. Compare the sequences of humans to the sequences of gorillas and horses. An example of a sequence difference between humans and gorillas is shown in Figure 26-1.

- Record in Table 26-1 the total number of differences in the sequences of gorilla and human amino acids. Then repeat this procedure for horse and human, and for gorilla and horse.

TABLE 26-1. NUMBER OF AMINO ACID SEQUENCE DIFFERENCES

ORGANISMS	NUMBER OF DIFFERENCES
Gorilla and human	
Horse and human	
Gorilla and horse	

Part B. Numbers of Amino Acids

- Count the number of each kind of amino acid in human hemoglobin. Record the totals in the proper column of Table 26-2.

- Count each amino acid in the hemoglobin of gorillas and horses. Record these in Table 26-2.

Human:	Val	His	Pro	This is a sequence difference between human and gorilla.
Gorilla:	Val	His	Gly	This is a sequence difference between gorilla and horse.
Horse:	Val	His	Pro	

This is not a sequence difference between human and horse.

FIGURE 26-1

FIGURE 26-2

Human:	Val	His	Leu	Thr	Pro	Glu	Glu	Lys	Ser	Ala	Val	Thr	Ala	Leu	Try
Gorilla:	Val	His	Leu	Thr	Pro	Glu	Glu	Lys	Ser	Ala	Val	Thr	Ala	Leu	Try
Horse:	Val	Glu	Leu	Ser	Gly	Glu	Glu	Lys	Ala	Ala	Val	Leu	Ala	Leu	Try
Human:	Gly	Lys	Val	Asp	Val	Asp	Glu	Val	Gly	Gly	Glu	Ala	Leu	Gly	Arg
Gorilla:	Gly	Lys	Val	Asp	Val	Asp	Glu	Val	Gly	Gly	Glu	Ala	Leu	Gly	Arg
Horse:	Asp	Lys	Val	Asp	Glu	Glu	Glu	Val	Gly	Gly	Glu	Ala	Leu	Gly	Arg
Human:	Leu	Leu	Val	Val	Tyr	Pro	Try	Thr	Glu	Arg	Phe	Phe	Glu	Ser	Phe
Gorilla:	Leu	Leu	Val	Val	Tyr	Pro	Try	Thr	Glu	Arg	Phe	Phe	Glu	Ser	Phe
Horse:	Leu	Leu	Val	Val	Tyr	Pro	Try	Thr	Glu	Arg	Phe	Phe	Asp	Ser	Phe
Human:	Gly	Asp	Leu	Ser	Thr	Pro	Asp	Ala	Val	Met	Gly	Asp	Pro	Lys	Val
Gorilla:	Gly	Asp	Leu	Ser	Thr	Pro	Asp	Ala	Val	Met	Gly	Asp	Pro	Lys	Val
Horse:	Gly	Asp	Leu	Ser	Asp	Pro	Gly	Ala	Val	Met	Gly	Asp	Pro	Lys	Val
Human:	Lys	Ala	His	Gly	Lys	Lys	Val	Leu	Gly	Ala	Phe	Ser	Asp	Gly	Leu
Gorilla:	Lys	Ala	His	Gly	Lys	Lys	Val	Leu	Gly	Ala	Phe	Ser	Asp	Gly	Leu
Horse:	Lys	Ala	His	Gly	Lys	Lys	Val	Leu	His	Ser	Phe	Gly	Glu	Gly	Val
Human:	Ala	His	Leu	Asp	Asp	Leu	Lys	Gly	Thr	Phe	Ala	Thr	Leu	Ser	Glu
Gorilla:	Ala	His	Leu	Asp	Asp	Leu	Lys	Gly	Thr	Phe	Ala	Thr	Leu	Ser	Glu
Horse:	His	His	Leu	Asp	Asp	Leu	Lys	Gly	Thr	Phe	Ala	Ala	Leu	Ser	Glu
Human:	Leu	His	Cys	Asp	Lys	Leu	His	Val	Asp	Pro	Glu	Asp	Phe	Arg	Leu
Gorilla:	Leu	His	Cys	Asp	Lys	Leu	His	Val	Asp	Pro	Glu	Asp	Phe	Leu	Leu
Horse:	Leu	His	Cys	Asp	Lys	Leu	His	Val	Asp	Pro	Glu	Asp	Phe	Arg	Leu
Human:	Leu	Gly	Asp	Val	Leu	Val	Cys	Val	Leu	Ala	His	His	Phe	Gly	Lys
Gorilla:	Leu	Gly	Asp	Val	Leu	Val	Cys	Val	Leu	Ala	His	His	Phe	Gly	Lys
Horse:	Leu	Gly	Asp	Val	Leu	Ala	Leu	Val	Val	Ala	Arg	His	Phe	Gly	Lys
Human:	Glu	Phe	Thr	Pro	Pro	Val	Glu	Ala	Ala	Tyr	Glu	Lys	Val	Val	Ala
Gorilla:	Glu	Phe	Thr	Pro	Pro	Val	Glu	Ala	Ala	Tyr	Glu	Lys	Val	Val	Ala
Horse:	Asp	Phe	Thr	Pro	Glu	Leu	Glu	Ala	Ser	Tyr	Glu	Lys	Val	Val	Ala
Human:	Gly	Val	Ala	Asp	Ala	Leu	Ala	His	Lys	Tyr	His				
Gorilla:	Gly	Val	Ala	Asp	Ala	Leu	Ala	His	Lys	Tyr	His				
Horse:	Gly	Val	Ala	Asp	Ala	Leu	Ala	His	Lys	Tyr	His				

Name _____ *Date* _____

TABLE 26-2. NUMBER OF EACH AMINO ACID				
AMINO ACID	ABBREVIATION	HUMAN	GORILLA	HORSE
Alanine	Ala			
Arginine	Arg			
Aspartic acid	Asp			
Cysteine	Cys			
Glutamic acid	Glu			
Glycine	Gly			
Histidine	His			
Leucine	Leu			
Lysine	Lys			
Methionine	Met			
Phenylalanine	Phe			
Proline	Pro			
Serine	Ser			
Threonine	Thr			
Tryptophan	Try			
Tyrosine	Tyr			
Valine	Val			

Analysis

1. Where is hemoglobin normally found? _____

2. Circle those words which correctly apply to or describe hemoglobin: protein, carbohydrate, composed of amino acids, chemical molecule, composed of DNA.

3. How many different kinds of amino acids are present in these three animals' hemoglobin? ____

4. (a) Which amino acid is most common in all three animals? _____

   (b) Which amino acid is next most common in all three animals? _____

   (c) Which amino acid is the least common in all three animals? _____

'9

5. Use your data from Table 26-1 to answer these questions.

   (a) How similar are the amino acid sequences of human and gorilla hemoglobin? _____

   (b) How similar are human and horse hemoglobin? _____

   (c) How similar are gorilla and horse hemoglobin? _____

6. Of the different types of amino acids found in hemoglobin,

   (a) how many are present in the same exact number in humans and gorillas? _____

   (b) in humans and horses? _____

   (c) in gorillas and horses? _____

7. On the basis of your answer to question 6,
   (a) how similar are the chemical makeups of human and gorilla hemoglobin? _____

   (b) how similar are human and horse hemoglobin? _____

   (c) how similar are gorilla and horse hemoglobin? _____

8. Which two animals seem to have more similar hemoglobin? _____
9. The sequence of amino acids corresponds to the sequence of base molecules in DNA. Are the base sequences of DNA most similar in human and gorilla, gorilla and horse, or human and horse?

   _____

10. In numbers, explain how the base sequences (genes) for hemoglobin formation on human chromosomes differ from those in gorillas. (How many bases are different?) _____

11. What genetic mechanism may have been responsible for this base sequence change? _____

    _____

12. Give reasons for supporting or rejecting the following statement. Upon examination, segments of human and gorilla DNA responsible for inheritance of hemoglobin should appear almost chemically alike. _____

    _____

    _____

13. Give reasons for supporting or rejecting the following statement. Evolutionary relationships are stronger between living organisms which have close biochemical (protein) similarities than between living organisms which do not have close biochemical similarities. _____

    _____

    _____

    _____

Name _____ Class _____ Period _____

29–2 How Do Fossils Show Change?

Most organisms live, die, and decompose. They leave no traces of having lived. Under certain conditions, an organism's remains or tracks may be preserved as a fossil. Fossils give clues about how an organism looked and where it lived. They are often used by scientists as evidence of change.

A fossil is any remains of a once-living thing. Fossils may only be the outline of some plant, animal, or other organism that is preserved in rock. Sometimes, entire skeletons of animals that lived millions of years ago are found.

GOALS

In this activity, you will:

a. examine diagrams of fossil horses and present-day horses shown in their surroundings.
b. examine diagrams of the structure of the front foot of fossil horses and present-day horses.
c. note the changes in horses that have taken place over time.

KEYWORDS

Define the following keywords:

adaptation _____

Equus _____

fossil _____

Hyracotherium _____

natural selection _____

_____

MATERIALS

metric ruler
colored pencils: red, blue, green, and yellow

PROCEDURE

Part A. Change in Size With Time

1. Examine the diagrams in Figure 1 of *Hyracotherium*, *Miohippus*, *Merychippus*, and *Equus*.
2. Use the diagrams to fill in Table I.

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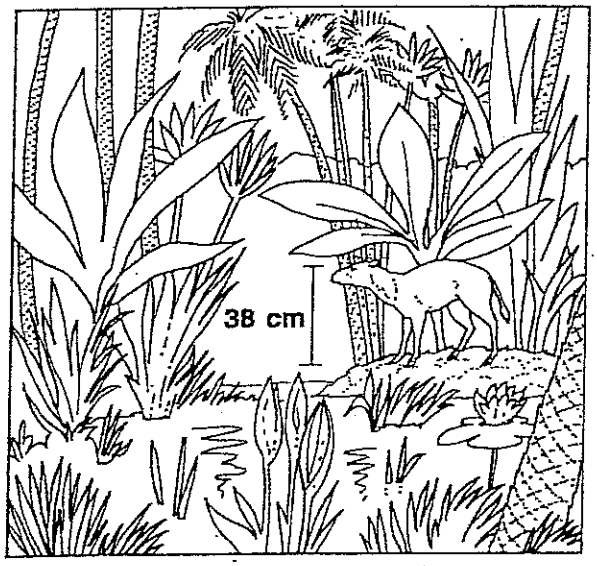
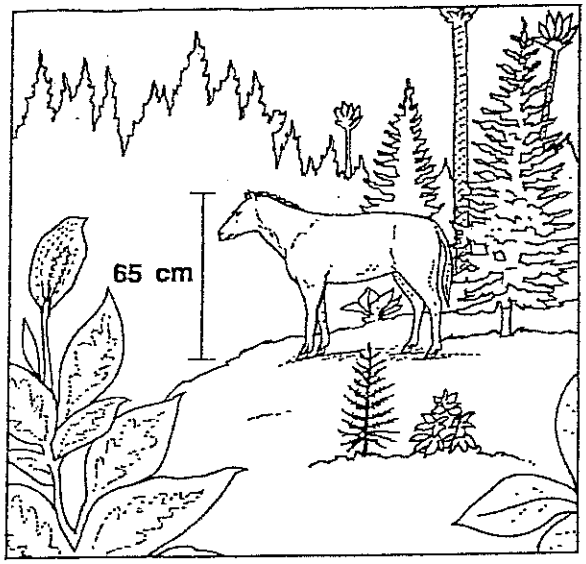
'able 1. Evolution in the Horse

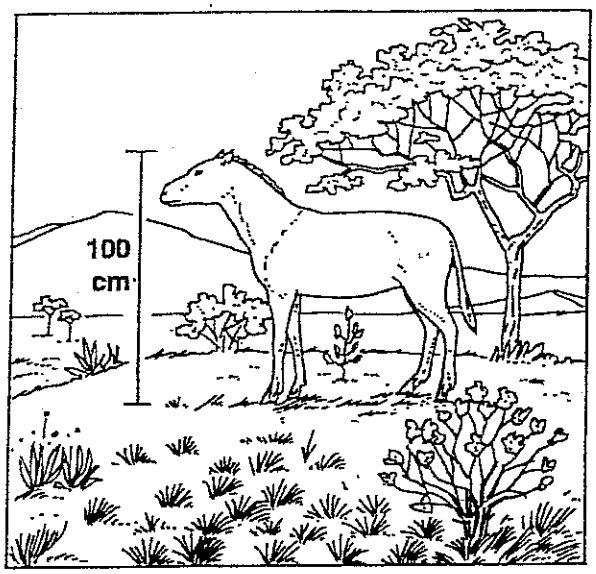
Horse	*Hyracotherium*	*Miohippus*	*Merychippus*	*Equus*
Size				
Type of surroundings				



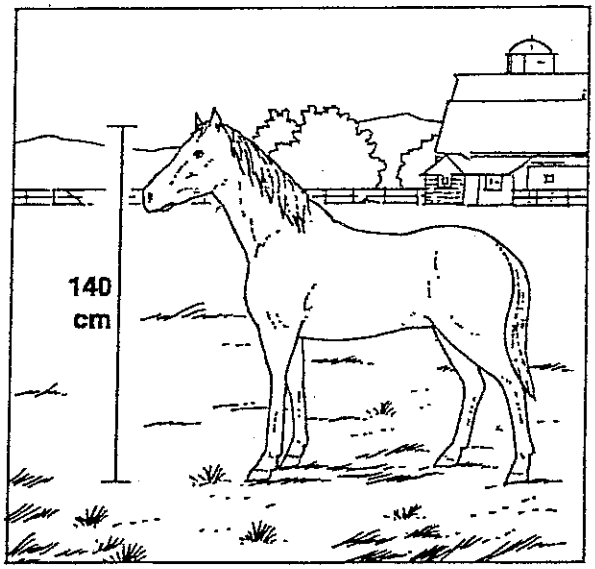
Hyracotherium
55 million years ago



Miohippus
30 million years ago



Merychippus
13 million years ago



Equus
Today

FIGURE 1. Evolution of the horse

Name _____ Class _____ Period _____

Part B. Changes in Bone Structures With Time

The changes in horses over the last 55 million years have been shown by studies of large numbers of fossils. The earliest kind of horse was small and had teeth that were adapted to browsing on young shoots of trees and shrubs. The present-day horse is much larger and has larger teeth that are adapted to grazing on the tough leaves of grasses. Early horses were adapted to living in wooded, swampy areas where more toes were an advantage. The single-hoofed toes of the present-day horse allow it to travel fast in the plains.

1. Examine the diagrams in Figure 2. They show fossils of the front foot bones and the teeth of horses. The foot bones at the upper right of each diagram indicate the relative bone sizes of each kind of horse.

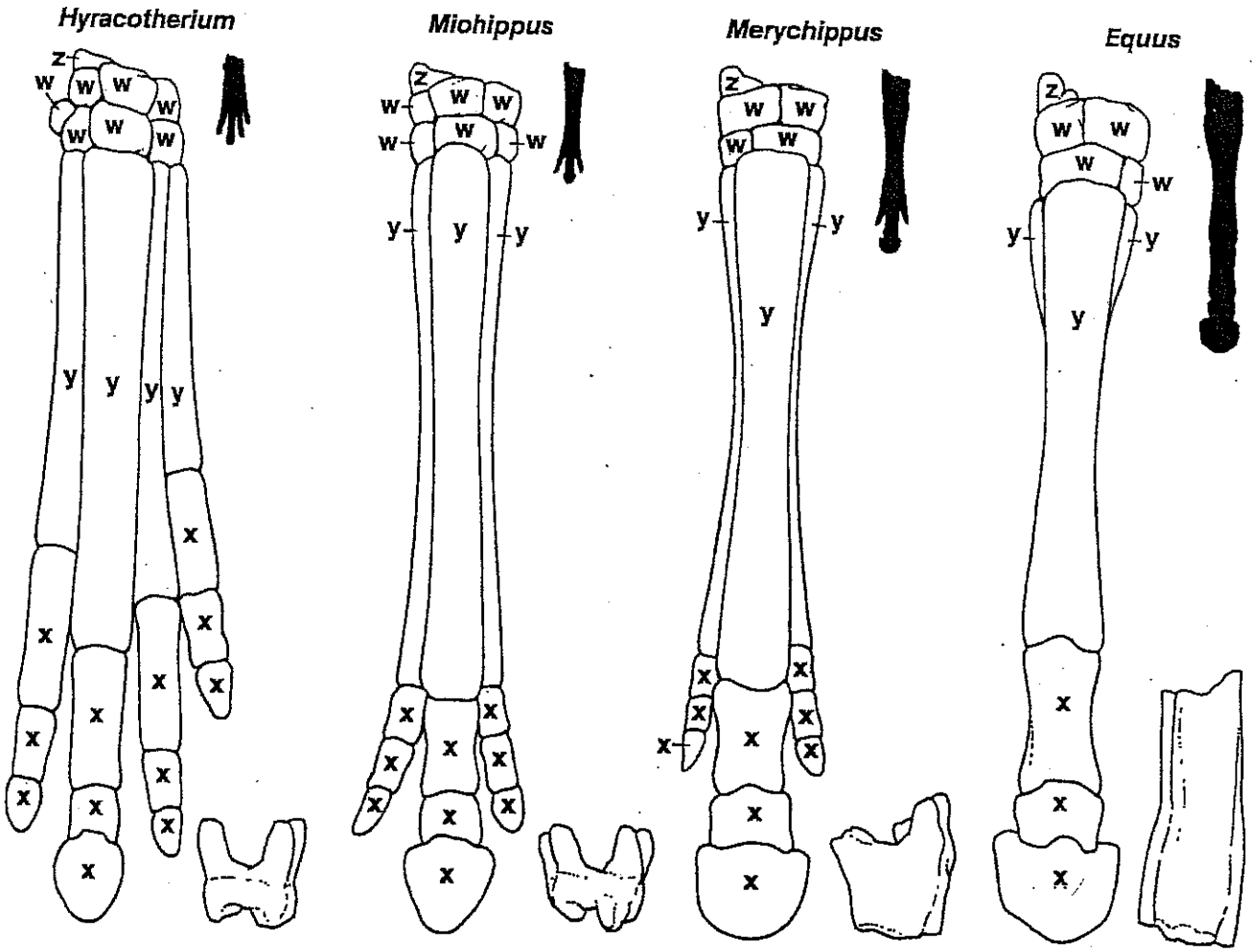


FIGURE 2. Forefoot bones and teeth of horses

2. Look for and color the following kinds of bones for each fossil horse.
   a. Color the toe bones red. These are marked for you with an *x*.
   b. Color the foot bones blue. These are marked with a *y*.
   c. Color the ankle bones green. These are marked with a *w*.
   d. Color the heel bones yellow. These are marked with a *z*.
3. Using the diagrams in Figure 2, make measurements to fill in Table 2.

Table 2. Evolution of the Horse

Kind of horse	*Hyracotherium*	*Miohippus*	*Merychippus*	*Equus*
Number of toes				
Number of toe bones				
Number of foot bones				
Number of ankle bones				
Number of heel bones				
Total number of foot bones				
Length of foot (measure inset diagrams) (mm)				
Height of teeth (mm)				

QUESTIONS

1. What changes occurred in the surroundings of horses from *Hyracotherium* to *Equus*?

2. What change occurred in the shape of the horse from *Hyracotherium* to *Equus*?

3. What changes occurred in the size of the horse from *Hyracotherium* to *Equus*?

4. As the surroundings changed, what happened to the teeth of the horse?

5. Describe the overall changes in foot length, number of toes, and size of toes in the horse over time.

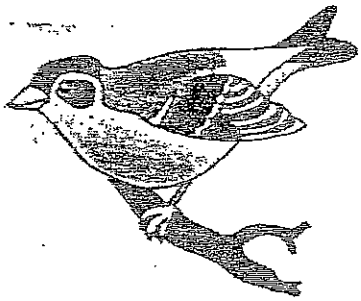
6. How would natural selection have caused changes in the size, feet, and teeth of the horse?

Name _____ Period _____ Date _____

Laboratory Activity #3 — Student Laboratory Packet

The Beaks of Finches

A Laboratory Activity for the Living Environment



Introduction

Environmental conditions act as selecting agents because they select organisms with the most beneficial traits to become the parents of the next generation. Within a species, individuals with variations that make them better adapted to their environment will survive and reproduce in greater numbers than those without such adaptations. Observations have shown that the offspring of better-adapted individuals inherit many of their parents' favorable variations.

Finches are small birds found in many locations throughout the world. Charles Darwin used the numerous finch species found on the Galapagos Islands as evidence of natural selection. The great variety of beak adaptations present on the Galapagos is thought to be due to the isolation of bird populations on the islands with different kinds and amounts of food. Seed-eating finches exhibit a great number of differences in beak shapes and sizes. During ongoing competition for resources, some finches are successful and become more numerous, while less successful finches decrease in number.

In this laboratory activity, you will work with different tools that will serve to model finch "beaks." The seeds provided represent finch food on a particular island. You will compete with other "finch" species to see which "beak" is best adapted for obtaining a specific food.

Objectives

In this laboratory activity, you will:

- learn how structural differences may affect the survival rate of members within a species
- simulate competition for resources among different species of organisms
- see the role of the environment as a selecting agent

Safety

- You should wear safety goggles for this activity.
- Handle the tools carefully. They may have sharp edges and could cause cuts.
- Be especially careful when two or more of you are reaching for seeds at the same time. The "beak" being used by one student has the potential to strike another student.
- Do not taste or eat any of the seeds.

Important Note: Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. Later, you will need to transfer your answers to a separate Student Answer Packet. Your teacher will use it in grading your work, and the school will retain it as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.

"The Beaks of Finches" is a laboratory activity produced by the State Education Department for use in fulfilling part of the laboratory requirement for the Regents Examination in Living Environment. Reproducing any part of this laboratory activity by other than New York State school personnel is illegal.

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Materials for Each Team

- 1 small plastic dish or cup
- 1 large nonbreakable dish
- 1 tool to serve as a "beak"
- large seeds (such as lima beans)*
- small seeds (such as lentils)
- 2 pairs safety goggles

* may be needed depending on results of Round One

Procedures

1. Examine the different tools ("beaks") and seeds provided. Predict which "beak" will be the *most* successful at picking up small seeds. Give the reasons for your choice.

   _____

   _____

   _____

2. Predict which "beak" will be the *least* successful at picking up small seeds. Give the reasons for your choice.

   _____

   _____

   _____

3. From this point on, you and your partner will model a finch feeding. The tool you were assigned will be your "beak." Describe what characteristics it has that make it good for picking up small seeds. In the remaining space or on a separate sheet of paper, draw an outline of your assigned "beak."

   _____

   _____

   _____

4. Both you and your partner should practice transferring the small seeds quickly from the large dish to the small dish before the competition begins. The large dish of small seeds represents the island environment where you live and feed. The small dish represents a finch stomach. You may move only one seed at a time. You will receive credit only for a seed that falls into and stays in the small dish.

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Round One: No Competition, Original Island

5. When given the "Round One" signal, one member of your team should use the "beak" to pick up small seeds one at a time from the large dish and place them in the small dish. Repeat this for a total of four trials, two trials for each partner. A timekeeper will tell you when to start and stop each trial. Record your results in the "Round One: Feeding with No Competition" data table.

Round One: Feeding with No Competition

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

6. Calculate the average number of seeds obtained during the four trials. Round off to the nearest seed. In order to "survive," your species needs to collect an average of 13 seeds per trial. If you achieve that goal, you remain healthy and continue to live on the original island and eat small seeds.

   If your team averaged fewer than 13 small seeds per trial, you and your partner will "migrate" to a new island with a different food supply to avoid starvation. Ask your teacher to give you a new large dish that contains approximately 200 or more large seeds. This will be your island for Round Two. Perhaps your "beak" will be better adapted for feeding success in a new environment.

Round Two: Competition

In this round, instead of feeding alone, you will be competing for food with finches that have different kinds of "beaks." To simulate this competition, your team will feed from the same dish as one other team. If you were successful during Round One, you will be feeding with other finches on small seeds. If you were not successful, you will be competing for large seeds.

7. In the "Round Two: Feeding with Competition" data table, *check the box that indicates whether you are feeding on the original island (small seeds) or on the new island (large seeds).* Complete four trials just as you did the first time and record the results of each trial. Again, wait for the time keeper to tell you when to start feeding and when to stop for each trial.

Round Two: Feeding with Competition

☐ **Original island (small seeds)** ☐ **New island (large seeds)**

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

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8. Calculate the average number of seeds obtained during the four trials. Round off to the nearest seed. If your team collected an average of 13 seeds or more per trial, you can go on to Round Three. If your team collected fewer than 13 seeds per trial, you and your partner are now eliminated.

Round Three: Increased Competition

During this round, you will be competing with all of the other finch species left alive on your island. In other words, all of the finch teams that were successful at feeding on small seeds will compete at one dish containing small seeds. At the same time, all of the finches successful at feeding on large seeds during Round Two will compete at one dish of large seeds.

9. In the "Round Three: Feeding with Increased Competition" data table, indicate whether you are feeding on small or large seeds. Complete four trials as before and record the results of each trial and your average.

Round Three: Feeding with Increased Competition

☐ Original island (small seeds) ☐ New island (large seeds)

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

Analysis Questions

1. What characteristics of your "beak" interfered with feeding success on the original island?

_____

_____

_____

2. Name three traits other than beak characteristics that could contribute to the ability of a finch to compete successfully.

_____

_____

_____

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3. It is very unlikely that all of the beaks within a species of finch are exactly alike. Random mutations and new gene combinations resulting from sexual reproduction are the source of beak variations. Describe at least three beak variations that could randomly appear and further improve your species' chances of survival when feeding on small seeds.

_____

_____

_____

4. Why did some "beak" types survive on the new island (with large seeds) when they could not survive on the original island?

_____

_____

_____

5. Class Activity: Complete the Class Results data table on the last page of this laboratory activity before going on to the remaining questions.

6. Did those who were successful in Round One survive equally well when others were competing for food at the same dish during Round Two? _____ Support your answer with an explanation.

_____

_____

_____

7. Why were there fewer survivors at the end of Round Three?

_____

_____

_____

8. At the end of Round Three, were the types of "beaks" that were successful on the new island the same as the types of beaks that were successful on the original island? _____ Support your answer with an explanation.

_____

_____

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19.

9. Explain how this activity simulates each of the concepts listed below as they are involved in the process of natural selection. Describe a specific example from this laboratory for each concept.

variation: _____

_____

competition: _____

_____

struggle for survival: _____

_____

adaptation: _____

_____

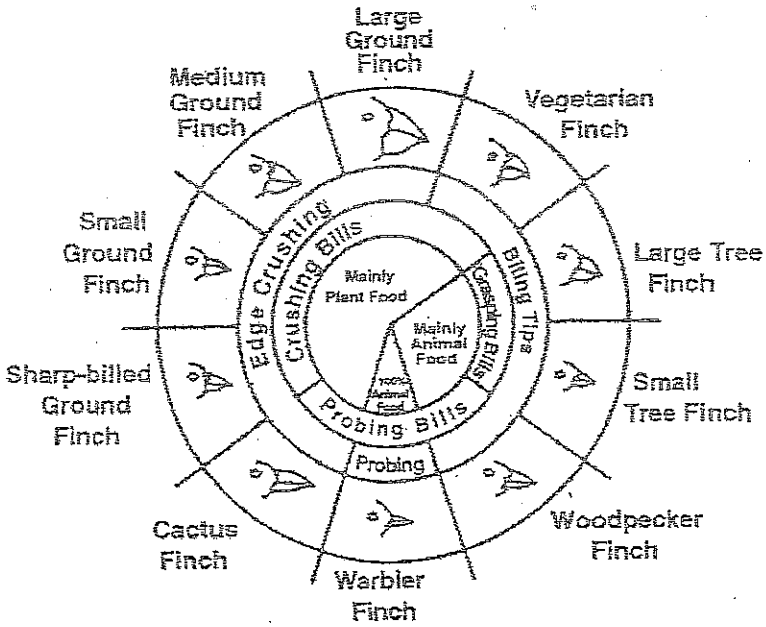
environment: _____

_____

selecting agent: _____

_____

Base your answers to questions 10-12 on Figure 1, which shows various finches found on the Galapagos Islands, and on your knowledge of biology.



— from *Galapagos: A Natural History Guide*

Figure 1. Variations in Beaks of Galapagos Islands Finches

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10. Predict which species of finch would be most likely to survive if the weather on the Galapagos Islands gradually changed and the seeds available to the finches became larger with heavier coverings. Support your answer with an explanation.

11. One island is populated by two species—Ground Finches and Small Tree Finches.

    a. What two types of food would you expect to be available on this island? Support your answer with an explanation.

    b. Would you expect the two species to compete for food on this island? Support your answer with an explanation.

    c. How might the two native finch populations be affected if several dozen Sharp-billed Ground Finches were to migrate to the island and survive? Support your answer with an explanation.

12. a. Explain how an island could support large populations of both Large Ground Finches and Small Ground Finches.

    b. How could you use the materials provided in this lab to test your explanation?

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Data Table for Question #5 of the Analysis Questions

Class Results

Beaks That Were	Number of Beak Types	Characteristics of Beaks (Size and Shape)
Present at the beginning of the activity		
Successful at feeding in Round One on the original island—fed on small seeds, did not need to migrate		
Not successful at feeding in Round One on the original island—fed on small seeds, had to migrate to the new island		
Successful at feeding in Round Two on the original island—fed on small seeds		
Successful at feeding in Round Two on the new island—fed on large seeds		
Not successful at feeding in Round Two on either island—species dies out		
Successful at feeding in Round Three on the original island—fed on small seeds		
Successful at feeding in Round Three on the new island—fed on large seeds		
Not successful at feeding in Round Three on either island—species eliminated		

Name Date

Evolutionary Changes In Primates

30

When paleontologists discover fossils, they determine whether they have discovered fossils of recent or early organisms. They then determine the kinds of organisms the fossils represent. If a skull were discovered and determined to be a primate skull, the next step would be to determine whether it is of an ape or a human. Because evolutionary change has occurred in both groups, the skull could be of early or modern ape or early or modern human. Because humans and apes evolved along separate lines, certain physical characteristics can be used in an attempt to classify the fossil skull as belonging to either ape (early or modern), early human, or modern human. Techniques similar to the ones used in this investigation are used by anthropologists, paleontologists, and archeologists.

In this investigation, you will

(a) examine gorilla, early human, *Australopithecus*, and modern human skull and pelvic diagrams.
(b) measure or observe and record specific skull and pelvic structures and features.
(c) evaluate evolutionary changes that have occurred in these organisms.

Materials

metric ruler
protractor

Procedure

Part A. Skull Characteristics

Brain Area Compared To Face Area

The rectangles over the skulls in Figure 30-1 represent the area of the brain (upper rectangle) and face (lower rectangle) of each skull.

• Determine the area of each rectangle by measuring the length and width in centimeters and multiplying the two measurements together.

• Record in lines 1 and 2 of Table 30-1 the brain and face areas for the gorilla, *Australopithecus*, and modern human skulls.

A comparison can be made as to whether the brain area is larger or smaller than the face area.

• Compare the brain and face areas and complete lines 3, 4, and 5 of Table 30-1.

Cranial Capacity

• Measure the diameter in centimeters of the circle in each skull. The diameter is the distance across the exact center of each circle.

• Multiply the cranial diameters by 200 cm^2. This gives the cranial capacity (brain volume) in cubic centimeters.

• Record the cranial capacity for each skull in line 6 of Table 30-1.

NOTE: This method of measuring cranial capacity differs from the method used when an intact skull is available.

Jaw Angle (Prognathism)

In front of each skull are two heavy lines, one running parallel to the slope of the upper jaw and one running through the nose. These two lines are to be used for measuring how far the jaw protrudes forward.

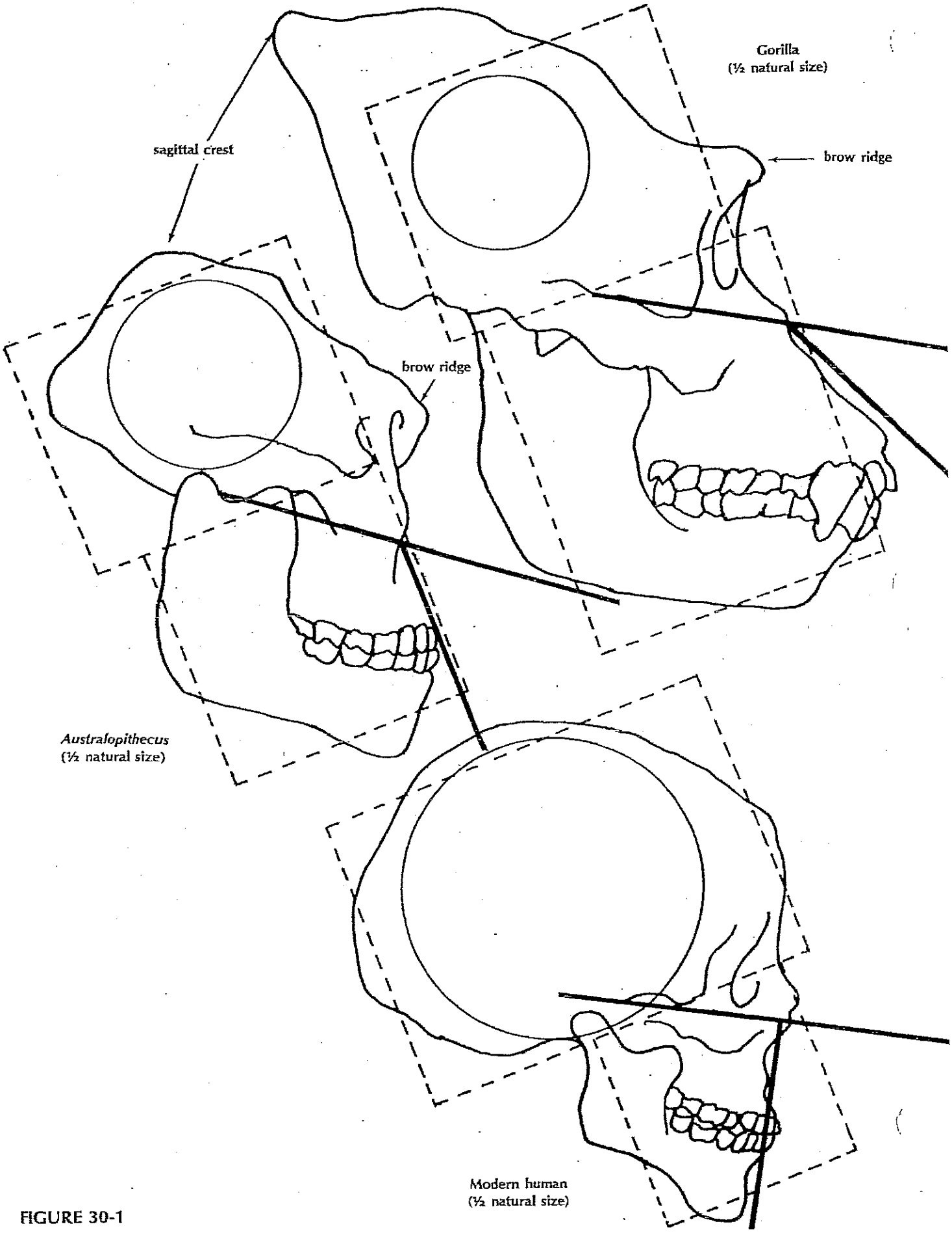

Gorilla
(½ natural size)
sagittal crest
brow ridge
brow ridge
Australopithecus
(½ natural size)
Modern human
(½ natural size)

FIGURE 30-1

Name Date

• With a protractor, measure the outside angle formed by the two lines in each skull (the angle toward the right).

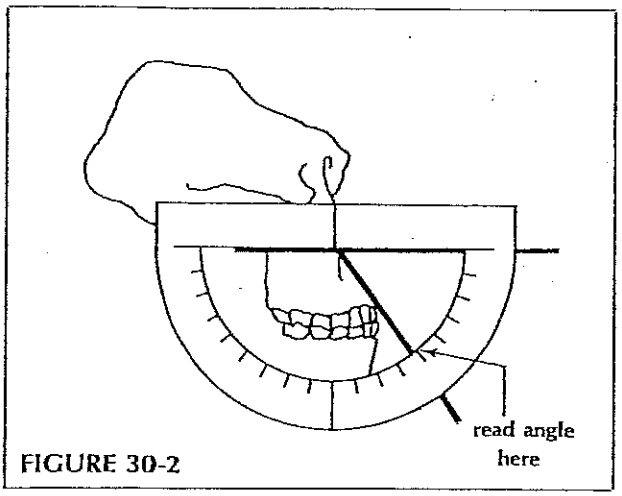


FIGURE 30-2

• Place the protractor onto each skull as shown in Figure 30-2. Read the angle by using the outside scale on the protractor. The angle is read where the lower skull line crosses the protractor.

• Record the angles in line 7 of Table 30-1. An angle of less than 90° means that the lower jaw sticks out in front of the nose. An angle of 90° means that the lower jaw does not stick out in front of the nose. Complete line 8 of Table 30-1.

Sagittal Crest

A bony ridge running across the top of a skull for muscle attachment is called a sagittal crest. This bony ridge is associated with heavy temporal muscles used to move the lower jaw.

• Indicate in line 9 of Table 30-1 whether a sagittal crest is absent or present in each skull. Refer to Figure 30-1.

Brow Ridge (Supraorbital Ridge)

Directly above the eye sockets is a thick bony ridge. This ridge may be absent or present in a skull.

• Indicate in line 10 of Table 30-1 whether or not a brow ridge is present.

Numbers and Types of Teeth

Use Figure 30-3 for this part of the investigation.

• Count and record the number of teeth for each lower jaw in line 11 of Table 30-1.

• Count the number of each tooth type for each lower jaw. "M" on Figure 30-3 is for molar, "P" is for premolar, "C" is for canine, and "I" is for incisor.

• Record in lines 12 to 15 of Table 30-1 the tooth type totals.

• Record in line 16 of Table 30-1 the size of canine teeth in each lower jaw.

• A diastema is a space between teeth. One can see a space in the lower jaw of the gorilla between the incisor and canine teeth. When the jaws were closed, the diastema allowed room for the large incisor teeth of the upper jaw. Record in line 17 of Table 30-1 if a diastema is or is not present in each lower jaw.

Lower Jaw Shape

The distance across the jaw backs compared to the distance across the jaw fronts can be used to determine jaw shapes of the three organisms in Figure 30-3 on page 119.

• Measure in centimeters the distance across each jaw from one dot to the other on the back molar teeth.

• Measure the distance across each jaw using the dots on the front pre-molar teeth.

• Record the distances for each jaw in lines 18 and 19 of Table 30-1. The distance across the back and front of a lower jaw will help to determine if the jaw is U- or V-shaped.

If the distance across the back of the jaw is the same as the distance across the front of the jaw, the jaw has a U shape. If the distance across the back is greater than the distance across the front, the jaw has a V shape. Complete lines 20, 21, and 22 of Table 30-1.

Pelvis Shape

Examine Figure 30-4. It shows the pelvises of our three skeletons from a side view. A line has been drawn across each one to indicate top and bottom.

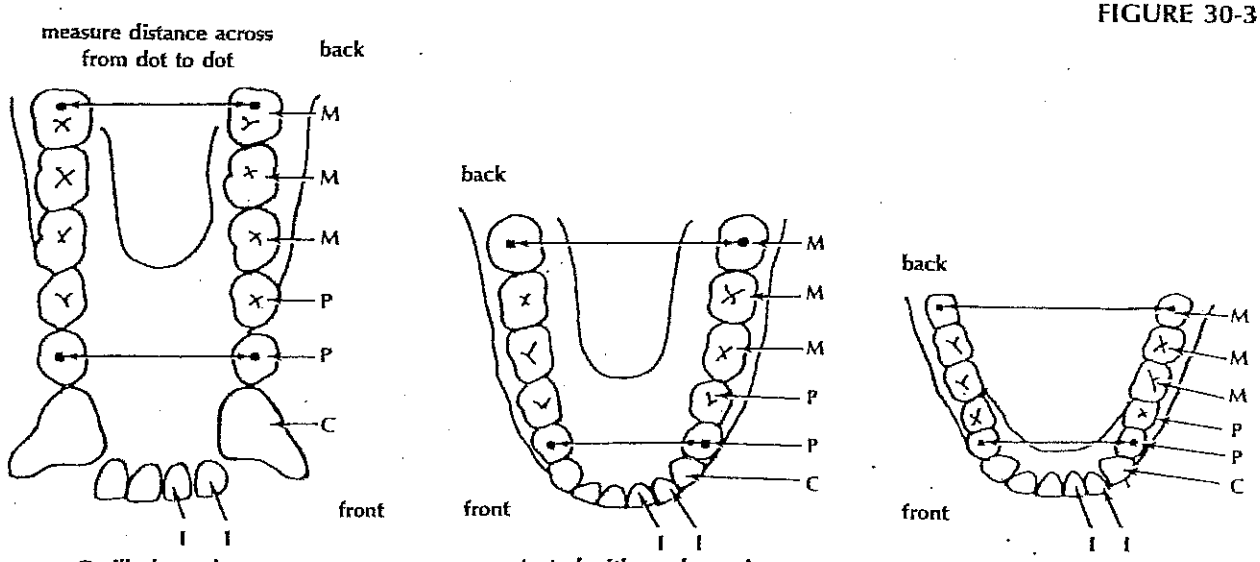
• Record in line 23 of Table 30-1 if the top half of each pelvis is wide and short or narrow and long.

• Record in line 24 of Table 30-1 if the bottom half of each pelvis is short or long.

TABLE 30-1. COMPARISON OF GORILLA, *AUSTRALOPITHECUS*, AND MODERN HUMAN SKULLS			
	GORILLA	*AUSTRALOPITHECUS*	MODERN HUMAN
1. Face area			
2. Brain rea			
3. Is brain area smaller than face area?			
4. Is brain area larger than face area?			
5. Is brain area 3 times larger than face area?			
6. Cranial capacity in cm^3			
7. Jaw angle			
8. Does lower jaw stick out in front of nose?			
9. Sagittal crest present			
10. Brow ridge present			
11. Number of teeth in lower jaw			
12. Number of molars in lower jaw			
13. Number of premolars in lower jaw			
14. Number of canines in lower jaw			
15. Number of incisors in lower jaw			
16. Size of lower jaw canines			
17. Diastema present			
18. Distance across back of jaw			
19. Distance across front of jaw			
20. Is distance across front and back of jaw the same?			
21. Is lower jaw U-shaped?			
22. Is lower jaw V-shaped?			
23. Shape of top half of pelvis			
24. Shape of bottom half of pelvis			

Name Date

FIGURE 30-3

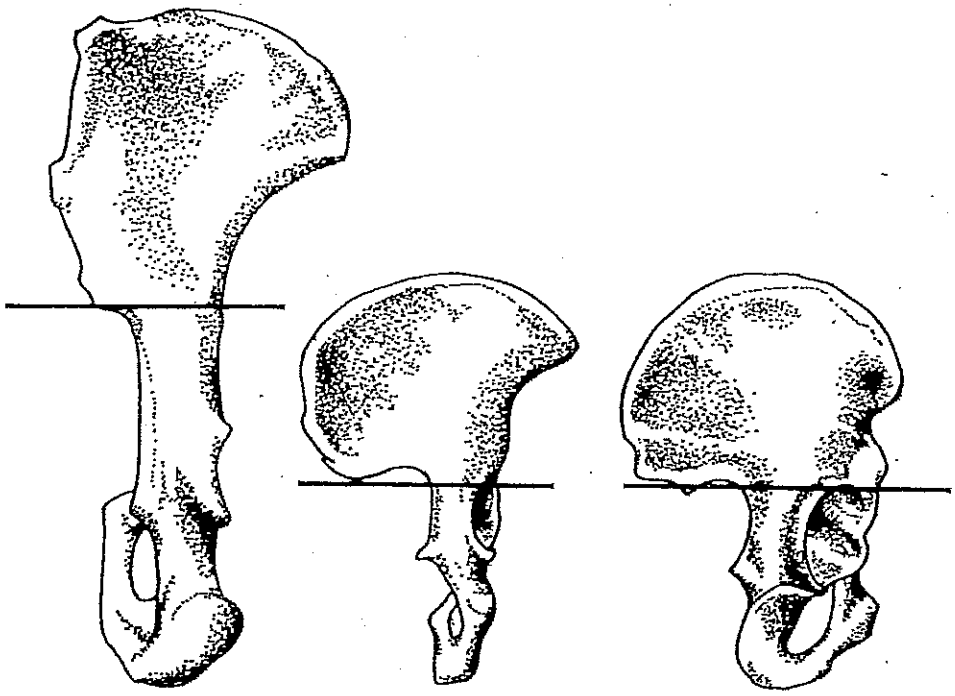


Gorilla lower jaw
(½ natural size)

Australopithecus lower jaw
(½ natural size)

Modern human lower jaw
(½ natural size)

FIGURE 30-4



Gorilla *Australopithecus* Modern human

Analysis

1. Using items 1–5 of your data in Table 30-1, describe the general change in face to brain area seen in the three animals studied. _____

2. Using item 6 of your data, describe the general change in cranial capacity seen in the three animals studied. _____

3. Using items 7 and 8 of your data, describe the general change in jaw angle and prognathism (how far the jaw protrudes forward) in the three animals studied. _____

4. Using items 9 and 10 of your data, describe the general change in brow ridge and sagittal crest in the three animals studied. _____

5. Using items 11–17 of your data, describe the general change in teeth number, size, and diastema in the three animals studied. _____

6. Using items 18–22 of your data, describe the general change in lower jaw shape in the three animals studied. _____

7. Using items 23 and 24 of your data, decide if *Australopithecus* was quadrupedal or bipedal. (The gorilla pelvis shape aids in its "walking on all fours," which is quadrupedal. The human pelvis shape aids in its walking on two legs, which is bipedal.) _____

8. How many traits are similar when comparing

   (a) gorilla to *Australopithecus*? _____

   (b) *Australopithecus* to modern human? _____

   (c) gorilla to modern human? _____

9. Based on your answer to question 8, does a modern human seem to be closer in evolutionary development to gorilla or *Australopithecus*? _____

Name _____ Date _____
Period _____ Ecology

BIOMES

Background:

A biome is defined as a large geographic region that has a particular type of climax community. Biomes are identified by the characteristic plants that dominate the landscape or by physical features and climate. While you are probably familiar with many of the biomes of the world, you may not know what causes biomes to exist. The species of plants and animals that coexist and survive in a particular area are determined by the soil, topography, and climate in that area. Keep in mind that the boundaries between biomes are not as distinct as you might think; they blend into each other quite well.

What makes an organism better suited to life in one biome rather than another? Organisms have adaptations that help them to survive in a particular biome. Adaptations are helpful variations found among the members of a population.

Objectives:

1. Research characteristics of Terrestrial and Aquatic biomes.
2. Color a map representing the world's biomes.
3. Investigate some of the physical processes that determine climate.
4. Construct a histogram of climate data for each biome.
5. Use your histogram to compare biomes.

Part 1: Biome Characteristics

Using the chart in this activity as a guide research each biome. Because you are working in groups it would be wise to delegate one or two biomes to each group member. After each member has researched his or her biome all information should be explained (NOT COPIED) to the other group members. In the column labeled "Climate Characteristics" include information that makes that biome unique. For example in the Tundra you would mention the Permafrost.

In the computer lab a "Lesson Zone" has been set up with various sites pertaining to Biomes. The username and password is "Biomes". These will be the only sites you have access to for this lab. Books will be provided as a resource as well. Your textbook is also a good source for this activity.

Be sure to color in the world map provided showing the locations of the biomes.

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Part 2: Some Earth Science Review ☺

I. Latitude and Radiant Energy:

Because the earth is shaped like a sphere, the sun's rays strike the earth at different angles (Figure 1). Although the amount of energy striking points A, B, C is equal, the amount that is absorbed depends on the angle of the sun's rays.

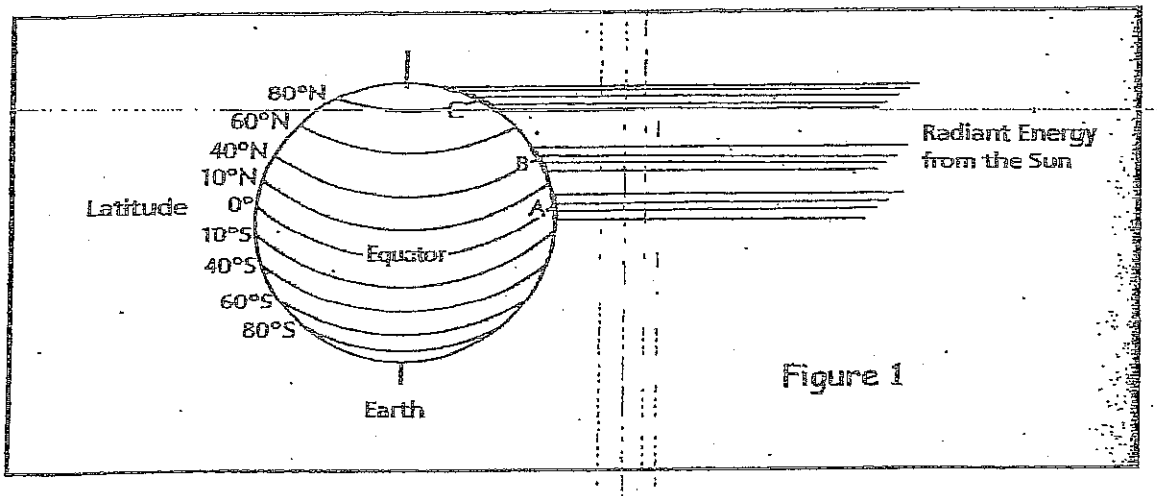


Figure 1

Consider the effect that latitude has on radiant energy absorption.

a. Why is more radiant energy absorbed at "A" rather than at "B"?

_____

_____

b. What immediate effect would be exhibited when the radiant energy strikes a particular part of the earth?

_____

_____

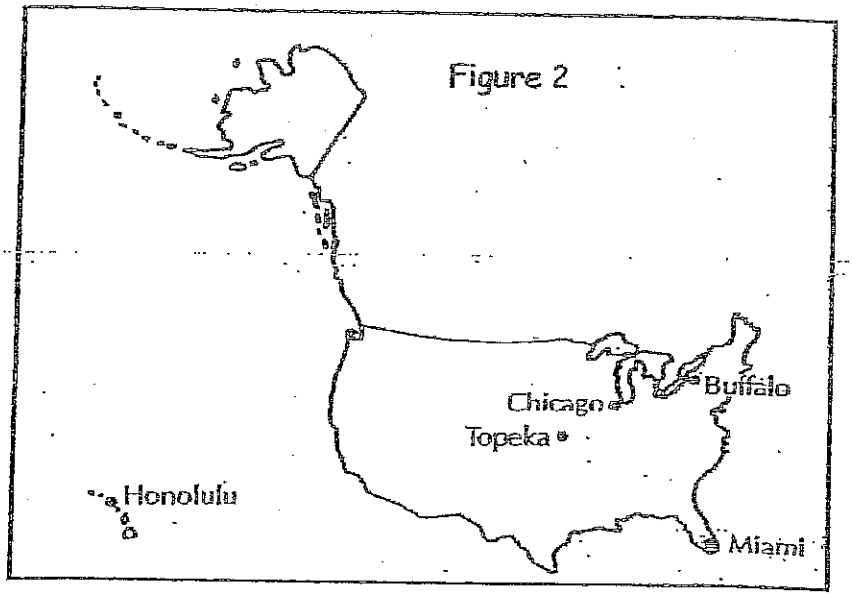
c. In general, what happens to temperature as one moves North or South of the equator?

_____

_____

II. Effect of Large Bodies of Water.

Land warms and cools quickly. Regions near the middle of a continent will experience temperature extremes, hot summers and cold winters. Water however, due to its high specific heat, warms and cools more slowly than land. In fact ocean temperatures in a given region do not vary much during the year. This causes the temperatures in coastal areas and on islands to be moderate. Large lakes and oceans also add humidity to the air and increase precipitation. "Lake Effect" snow results from cold air blowing across a large lake, gathering moisture and then, upon further cooling, dropping moisture in the form of snow on the shoreline and slight inland



a. In which of the cities shown in Figure 2 would the most consistent temperatures be found?

_____

_____

b. Where would extremes in temperature be expected?

_____

_____

c. Where would the most precipitation be expected?

_____

_____

d. Where would precipitation likely fall as lake effect?

_____

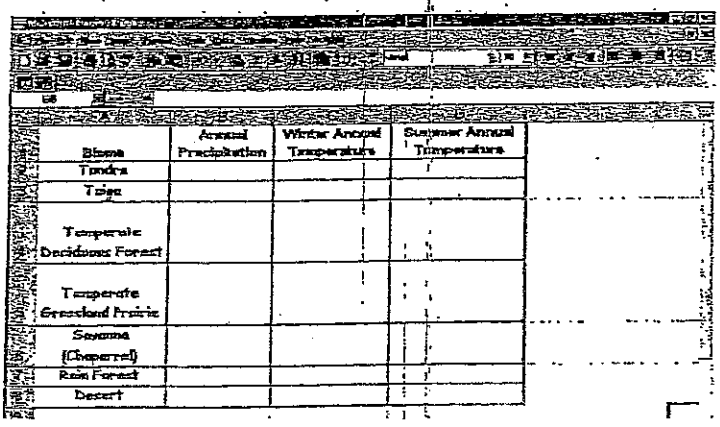
_____

Part 3: Graphing Climate Data

Using the table below construct a histogram for average precipitation and 2 histograms for average temperature ranges (1 for summer averages and 1 for winter averages).

Biome	Yearly Average Precipitation	Yearly Temperature Range (Winter & Summer)
Tundra	12 cm/yr (Less than 25 cm)	Winter -28°C Summer -9°C
Taiga	33 cm/yr Less in the North	Winter -25°C Summer 20°C
Temperate Deciduous Forest	120 cm/yr	Winter -10° Summer 26°C
Temperate Grassland Prairie	50 cm/yr	Winter -5°C Summer 28°C
Savanna (Chaparral)	90 cm/yr	Winter 12°C Summer 20°C
Rain Forest	200 cm/yr	Winter 2°C Summer 20°C
Desert	12 cm/yr (Less than 25 cm)	Winter 8°C Summer 39°C

1. Open the Excel Program
2. Begin to type in the data from the table above. For Each histogram you need to have a separate column of data. (See figure below)



Biome	Annual Precipitation	Winter Annual Temperature	Summer Annual Temperature
Tundra			
Taiga			
Temperate Deciduous Forest			
Temperate Grassland Prairie			
Savanna (Chaparral)			
Rain Forest			
Desert			

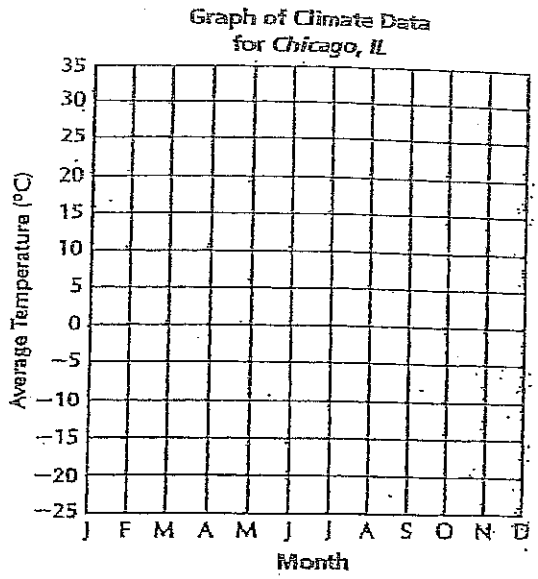
3. Highlight the data in column A and column B. Click on the Chart Wizard. (Hint: It's on the top of the Excel toolbar and looks like a bar graph)
   And choose the Option for column Graph. Select graph 4.
4. Click "Next"
5. Type in the axes information and graph title. (The Z axis is the Y axis on a line graph)
6. Click "Next" and then "Finish"
7. Drag the ends of the graph to make it larger
8. Now you have to make some alterations to the graph so all of the data can be seen. To change the font on the X axis right click on the text. Then choose the format axis option. Change the font so it is the appropriate size for the graph (usually about 8). Then change the alignment to 90°.
9. Because the histogram is labeled you do not need to have a legend. Right click on it and clear it.
10. Repeat these steps for the Annual Winter and Summer Temperatures. (HINT: to highlight the data in column A and Column C at the same time hold down the control (Ctrl) and Alternate (Alt) keys simultaneously.)

Place all three graphs on one sheet and print them out.

Use the graphs you constructed to answer the following question.

Graph the following data given below for Chicago IL below.

	Temp. (°C)	Precip. (cm)
J	−4.4	4.8
F	−2.7	4
M	2.8	6.9
A	10	9.6
M	15.5	8.6
J	21.7	10.1
J	23.9	10.4
A	23.3	7.8
S	18.9	7.6
O	12.8	6.6
N	4.4	5.6
D	−1.6	5.3



In what biome might Chicago be classified? Why?

_____

_____

_____

Biome	Climate Characteristics	Indigenous Flora & Adaptations	Indigenous Fauna & Adaptations	
Tundra				
Taiga (Coniferous Forest)				
Temperate Deciduous Forest				
Temperate Grassland Prarie				
Desert				
Savanna (Chaparral)				
Tropical Rain Forest				

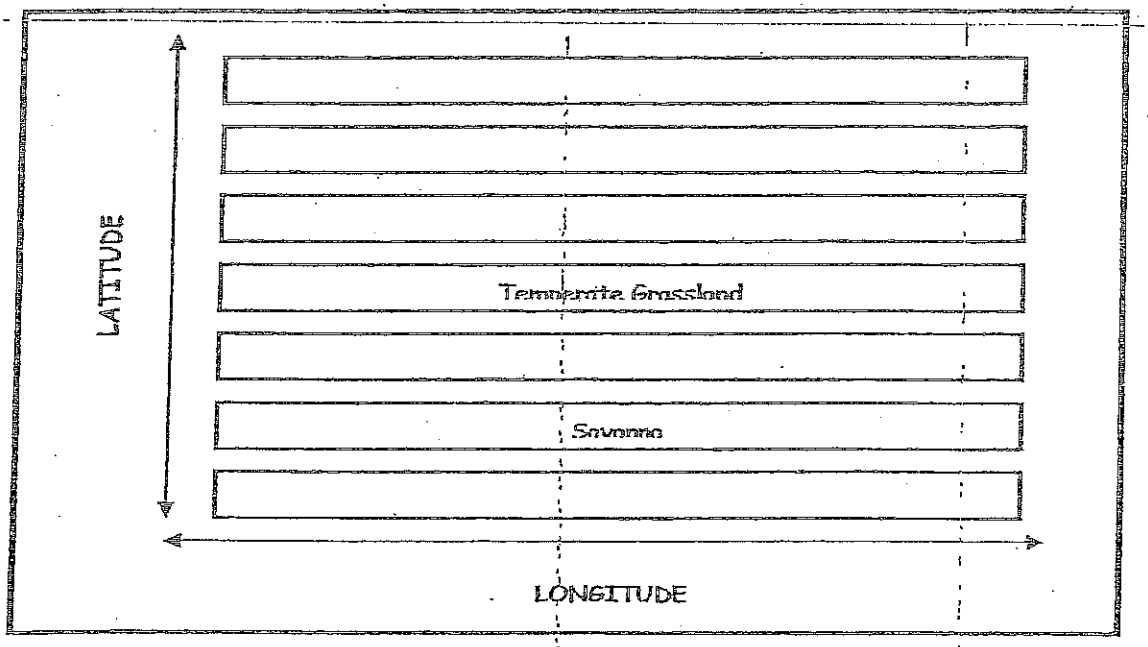
Characteristics of Major Aquatic Biomes

MARINE BIOME	Depth	Indigenous Flora & Adaptations	Indigenous Fauna & Adaptations
Intertidal Zone			
Pelagic Zone			
Benthic Zone			
Abyssal Zone			
FRESHWATER BIOME	**Depth**	**Indigenous Flora & Adaptations**	**Indigenous Fauna & Adaptations**
Littoral Zone			
Limnetic Zone			
Profundal zone			

Analysis & Conclusion Questions:

1. How are Biomes identified?

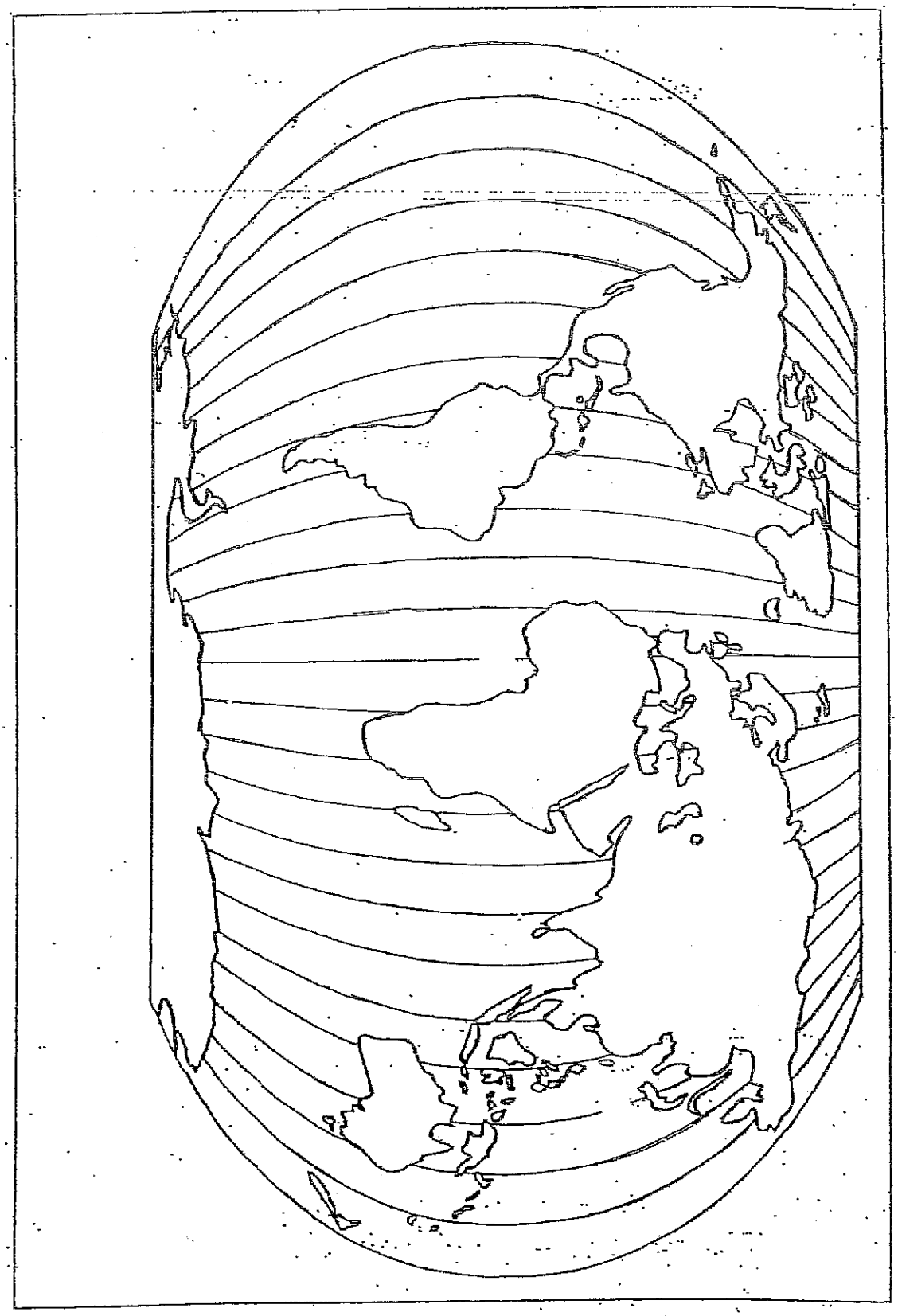
2. Fill in the following graphic organizer with the proper biomes.



3. How does plant life in a biome affect the kinds of animals found in that biome?

4. What determines the type of Biome found in a particular area?

5. What would happen if a new species of plant or animal were introduced to the biome? How would it affect the balance of the ecosystem? Do you think the new species would survive? Why or Why not?



Name _____ Class _____ Period _____

Before doing this lab, have students read sections 30:1–30:2 and 30:6–30:7 in the text.

30–2 What Are Some Parts of a Food Chain and a Food Web?

Plants use light energy of the sun to make food. The food is stored in the cells of the plant. Plants are called producers because they make food. Some of the stored energy in the food that plants make is passed on to the animals that eat the plants. Plant-eating animals are called primary consumers. Some of the energy is passed on to the animals that eat primary consumers. Animals that eat other animals are called secondary consumers.

The pathway that food energy takes through an ecosystem is called a food chain. A food chain shows the movement of energy from plants to plant eaters and then to animal eaters. An example of a food chain can be written as follows:

(producer)		(primary consumer)		(secondary consumer)
seeds	→	sparrow	→	hawk

Some of the food energy in the seeds moves to the sparrow that eats them. Some of the food energy then moves to the hawk that eats the sparrow.

Because a hawk eats animals other than sparrows, you could make a food chain for each animal the hawk eats. If all the food chains were connected, the result is a food web. A food web is a group of connected food chains. A food web shows many energy relationships.

GOALS

In this exercise, you will:

a. determine what different animals eat in several food chains.
b. build a food web that could exist in a forest ecosystem.

KEYWORDS

Define the following keywords:

consumer _____

food chain _____

food energy _____

food web _____

producer _____

MATERIALS

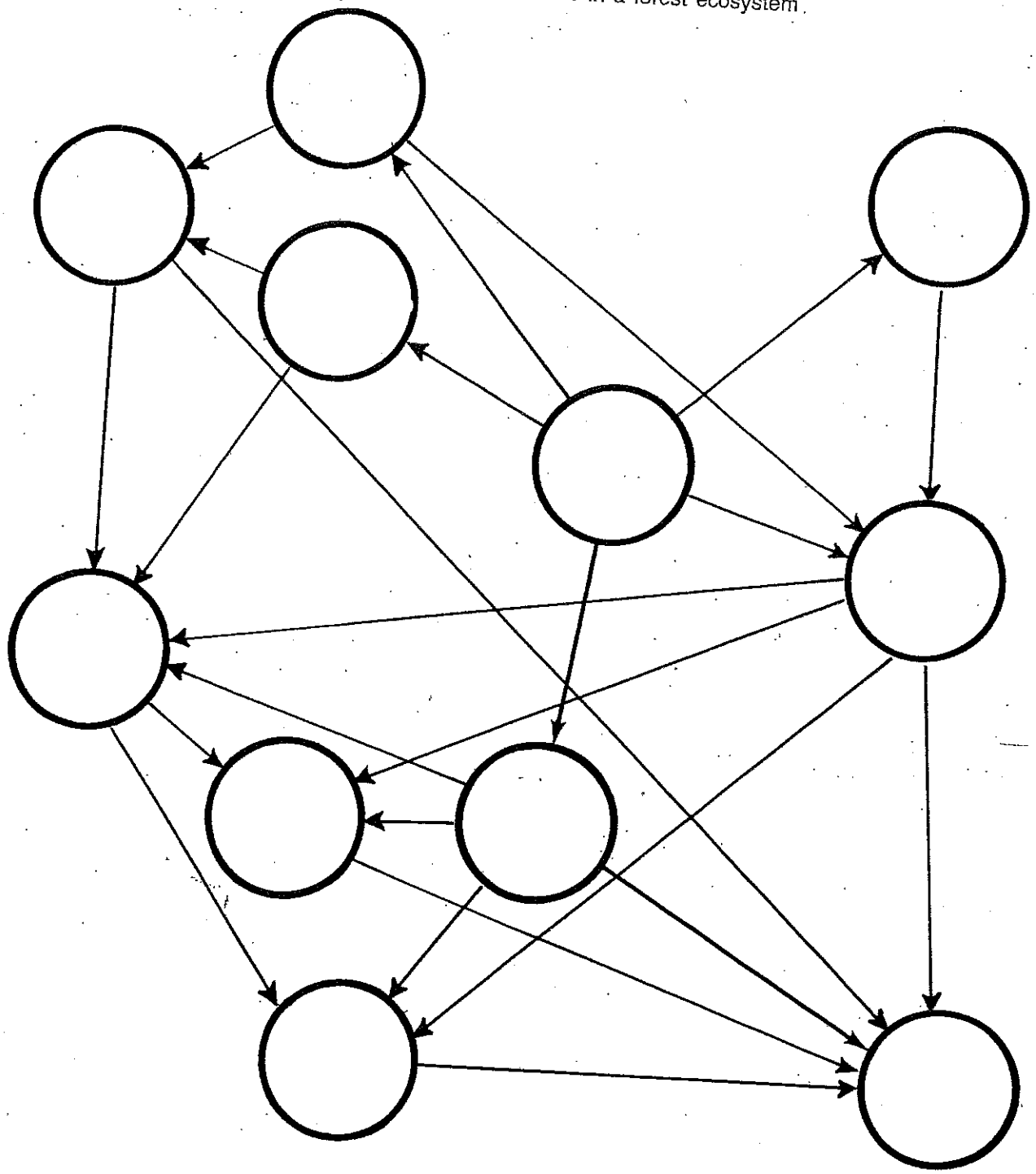
colored pencils metric ruler

Name _____ Class _____ Period _____ 348

Part B. Making a Food Web

1. Use the information in Part A on the previous page to complete Figure 1.
2. Draw lines from each organism to other organisms that eat it.
3. Show which organism gets the energy by making an arrow pointing in the direction of energy flow from producers to primary consumers, to secondary consumers. One food chain has already been done for you.
4. Draw your lines with different colored pencils for different food chains. To make it easier to read when finished, do not draw through the circles.

FIGURE 1. A food web in a forest ecosystem



PROCEDURE

Part A. Examining Food Chains

1. Read the introduction and examine the food chains given below.

(producer)	(primary consumer)	(secondary consumers)		
plant roots →	rabbit →	fox		
plant seeds →	mouse →	fox		
plant leaves →	earthworm →	robin →	snake	
plant leaves →	rabbit →	snake		
plant leaves →	cricket →	robin →	fox	
plant stems →	earthworm →	snake →	hawk →	fox
plant stems →	rabbit →	hawk		
plant stems →	small insects →	mouse →	owl	
plant leaves →	rabbit →	owl →	fox	
plant leaves →	cricket →	mouse →	hawk	
plant fruits →	mouse →	snake →	owl	
plant fruits →	small insects →	robin →	snake	

2. Answer the questions that follow:

a. List the organisms that you think are producers._____

b. Why are they called producers?_____

c. List the organisms that you think are primary consumers._____

_____

d. Why are they called primary consumers?_____

e. List the organisms that you think are secondary consumers._____

_____

f. Why are they called secondary consumers?_____

g. Herbivores are organisms that eat plants. List the herbivores in the food chains._____

h. How does your list of herbivores compare with your list in question c?_____

_____

i. Carnivores are organisms that eat other animals. List the carnivores in the food chains._____

j. How does your list of carnivores compare with your list in question e?

_____

k. Make two food chains using animals not listed in the above food chains.

→ _____

_____

(Answers will vary.)

QUESTIONS

1. How many of the food chains you made in Figure 1 include the following animals? hawk _____ earthworm _____ fox _____

   small insects _____ owl _____ snake _____

2. How many of the food chains include plant parts? _____
3. Give the names of the producers that are in the food web. _____
4. Give the names of the consumers that eat both plants and animals.

   _____

5. What would happen to the food web if all the plants were removed?

   _____

   Explain your answer. _____

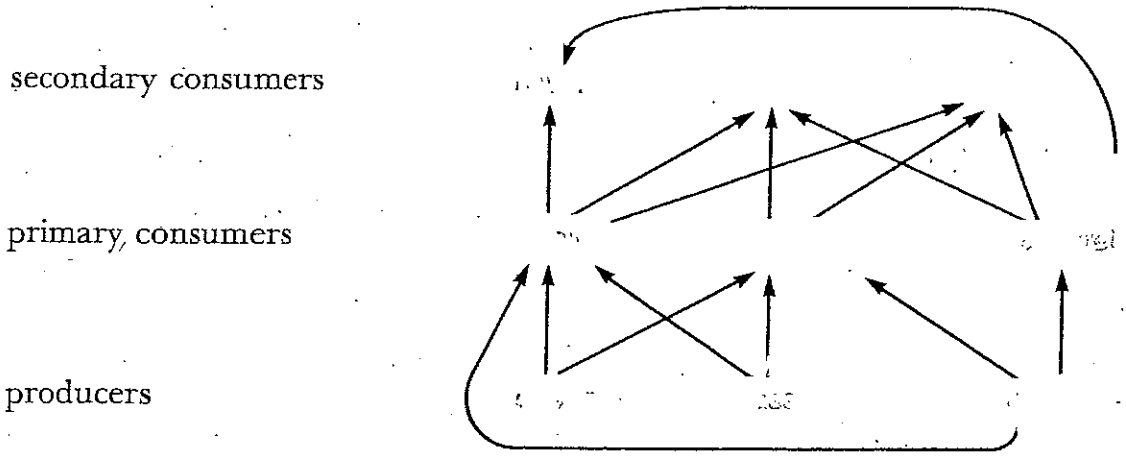
   _____

6. What might happen to the owl population if there were less rabbits, mice, and snakes in a certain year? _____
7. What organisms will be affected if crickets, small insects, and earthworms are killed by pesticides? _____

   _____

   _____

8. Draw three food chains below that can be connected in a food web. Show producers and consumers that you might see in your backyard or on your way to school.



NAME _____ DATE _____

PARTNER _____ TEACHER _____

Predator-Prey Relationships: Rabbits and Lynxes

BACKGROUND: There are many feeding relationships to be found in the typical ecosystem. One of these is the predator-prey relationship. Studies such as the one reproduced in this lab have shown that this relationship is far more complex than one animal eating another.

A study conducted over a period of more than 90 years counted the population of lynx and the population of rabbits in a specific area. Scientists noted a pattern to the population changes for each organism.

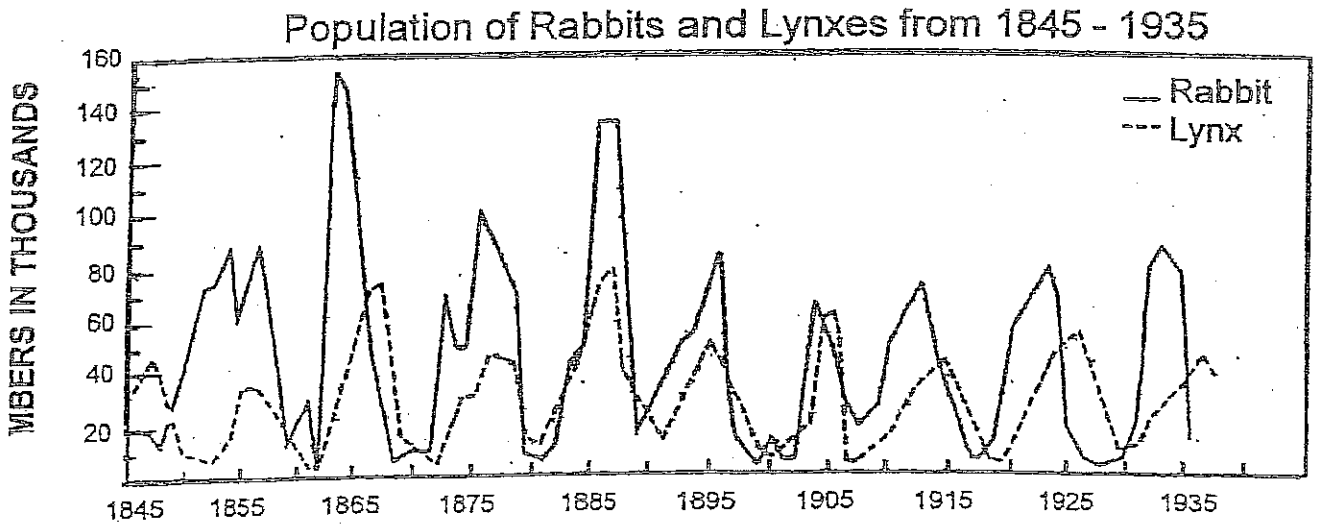
OBJECTIVES: In this activity you will:

1. Analyze a graph of population data for rabbits and lynxes in an ecosystem
2. Determine the pattern illustrated in the data.
3. State an explanation for this pattern.

HYPOTHESIS: _____

_____

_____



PROCEDURE:

1. Working with your partner, examine the graph on the previous page that shows the population fluctuation of rabbit vs. lynx.

2. One of you will record data on the lynx while the other records data on the rabbit.

3. Enter the population of your animal in the space provided for each year.

4. Indicate by using an **arrow** whether this number is higher or lower with respect to the previous five years. For example:

Year	Rabbit	Lynx
1865	80,000 ⇩	60,000 ⇧

5. Exchange data with your partner, then calculate the total population for each animal.

6. Calculate the average population for 90 years for each animal. **Note:** *Although the data covers 90 years, you do not have 90 readings. Do not divide by 90.*

7. Using a different color for each species, draw a horizontal line on the graph indicating the average population for each species.

CHANGES IN THE POPULATION OF RABBITS AND LYNXES FROM 1845 - 1935		
Year	Rabbit Population	Lynx Population
1845		
1850		
1855		
1860		
1865		
1870		
1875		
1880		
1885		
1890		
1895		
1900		
1905		
1910		
1915		
1920		
1925		
1930		
1935		
Total Population		
Average Population for 90 Years		

354

ANALYSIS:

1. Which species has a larger population overall?

2. How many "peaks" are there above the average line for the rabbit? For the lynx?

3. Do the "peaks" occur at the same time for each population? Explain.

4. Between 1885 and 1890, what happened to the rabbit population?

5. Consider 1885-1890 a short-term period and 1845-1935 a longer-term period. Which is more stable (i.e., the populations most closely resemble the average population), the short-term period or the longer-term period?

6. Why does the rabbit population start to increase a few years before the lynx population increases?

7. When the lynx population is at its maximum, is the rabbit population increasing or decreasing? Why?

8. What keeps the number of lynxes controlled?

9. What keeps the numbers of rabbits controlled?

10. What would happen to the rabbits if the lynxes were eliminated from this environment?

11. What would happen to the lynxes if the rabbits were eliminated from this environment?

CONCLUSIONS:

1. In The Lion King. the zebras and the lions live together. Explain what may happen in each of the following situations. Predict BOTH the short-term changes and the long-term changes.
   a. The zebra population increased.
   b. The lion population increased.
   c. The zebra population contracted a virus that killed 75% of the population.
   d. The lion population suffered from a parasitic infection that killed 75% of the population.

2. Give three examples that show you are dependent on other people in school and explain how this contributes to the stability of the school environment.

3. Give "real life" examples that illustrate how three different populations in an ecosystem are dependent on each other and as a result their numbers are relatively stable over the long term.

4. Using the example from number 3, predict how the elimination of one population might affect the remaining populations.

Name _____	Date _____
Partner _____	Teacher _____

The Lesson of the Kaibab

Background: The environment may be altered by forces within the biotic community, as well as by interactions between organisms and the physical environment. The carrying capacity of an ecosystem is the maximum number of organisms that the ecosystem can support on a sustained basis. The changing density of a population may produce such profound changes in the environment that the environment becomes unsuitable for survival of that species. Humans can interfere with these natural interactions and have either a positive or negative effect.

Objectives:

- Graph the size of the Kaibab deer population of Arizona from 1905 to 1939.
- Analyze the actions responsible for the changes in the deer population.
- Propose a management plan for the Kaibab deer population.

Materials:

Colored pencils (1 green and 1 red)

Procedure:

Before 1905, the deer on the Kaibab Plateau in Arizona were estimated to number about 4000 on almost 300,000 hectares of range. The average carrying capacity of the range was estimated then to be about 30,000 deer. On November 28, 1906, President Theodore Roosevelt created the Grand Canyon Game Preserve to protect the "finest deer herd in America."

Unfortunately, by this time the Kaibab forest area had already been overgrazed by sheep, cattle and horses. Most of the tall perennial grasses had been eliminated. The first step to protect the deer was to ban all hunting. In addition, in 1907, the Forest Service tried to exterminate the predators of the deer. Between 1907 and 1939, 816 mountain lions, 20 wolves, 7388 coyotes, and more than 500 bobcats, all predators of the deer, were killed.

1. Using the green pencil, draw and label a straight horizontal line across the graph in Data and Observations to represent the carrying capacity.
2. Using the red pencil, graph the data in Table 1.
3. Answer Analysis questions 1- 4.

Table 1

Deer Population from 1905 to 1924	
Year	Deer Population
1905	4,000
1910	9,000
1915	25,000
1920	65,000
1924	100,000

Signs that the deer population was out of control began to appear as early as 1920. The range was beginning to deteriorate rapidly. The Forest Service reduced the number of livestock-grazing permits. By 1923, the deer were reported to be on the verge of starvation, and the range conditions were describes as "deplorable".

A Kaibab Deer Investigating Committee recommended that all livestock not owned by local residents be removed immediately from the range and that the number of deer be cut in half as quickly as possible. Hunting was reopened, and during the fall of 1924, 675 deer were killed by hunters. However, these deer represented only one-tenth the number that had been born that spring.

4. Using the red pencil, plot the data in Table 2 on your graph. Label the completed graph.
5. Answer Analysis questions 5 and 6.

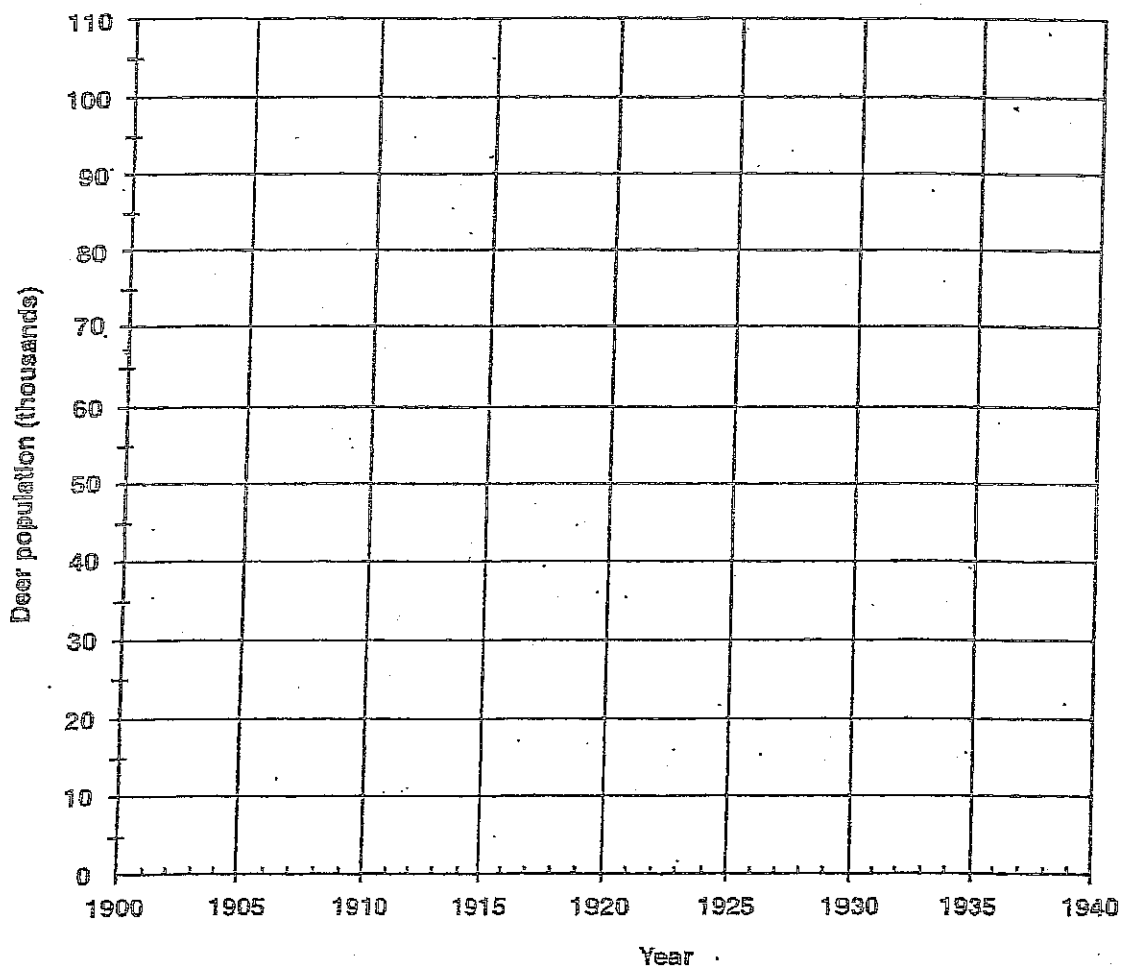
Table 2

Deer Population from 1925 to 1939	
Year	Deer Population
1925	60,000
1926	40,000
1927	37,000
1928	35,000
1929	30,000
1930	25,000
1931	20,000
1935	18,000
1939	10,000

Today, the Arizona Game Commission carefully manages the Kaibab areas with regulations geared to specific local needs. Hunting permits are issued to keep the deer balance within their range. Predators are protected to help keep herds in balance with food supplies. Tragic winter losses can be checked only by keeping the number of deer near the carrying capacity of the range.

6. Answer Analysis questions 7 – 10.

Data and Observations



Analysis:

1. In 1906 and 1907, what two methods did the Forest Service decide to use to protect the Kaibab deer?

_____

_____

2. How many total predators were removed from the preserve between 1907 and 1939?

_____

3. What was the relationship of the deer herd to the carrying capacity of the range:

in 1915?_____
in 1920?_____
in 1924?_____

4. Did the Forest Service program appear to be successful between 1905 and 1924? Explain your answer.

_____

_____

_____

5. Why do you suppose the population of the deer declined in 1925 although the predators were being removed?

_____

_____

_____

6. Do you think any changes had occurred in the carrying capacity of the range from 1900 to 1940? Explain your answer.

_____

_____

_____

7. Why do you suppose the population of deer in 1905 was 4000 when the range had an estimated carrying capacity of 30,000?

_____

_____

_____

8. Without the well-meaning interference of humans, what do you think would have happened to the deer population after 1905?

_____

_____

_____

9. What major lessons were learned from the Kaibab deer experience?

_____

_____

_____

10. If the lessons learned from Kaibab deer studies had been known then, what recommendations would you have made in 1915?.

_____

_____

in 1923?_____

_____

in 1939?_____

_____

Further Explorations:

1. Many forests have been endangered by gypsy moth caterpillars. Research how they came to the United States and the methods that have been proposed to control them.
2. Mosquitoes are a great annoyance to many people. Obtain some books from your teacher or librarian that contain information on mosquitoes. Decide whether or not you would try to eliminate them. Justify your answer.